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CONSERVATION OF THE COAL SUPPLY.

Much has been written in this country in recent years in regard to the danger of exhausting our coal measures and regarding methods for husbanding the visible supply. The discovery of the immense coal fields of Alaska has made this question less momentous than it was formerly, but the problem is an ever-present one whose importance must become more accentuated as time rolls on. The question is now attracting attention in England as well as in this country, and the inaugural address of President S. Z. de Ferranti of the English Institution of Electrical Engineers, which is abstracted upon other pages of this issue, dealt with this question and its influence upon other conditions in England, such as the food supply and the better utilization of labor.

Mr. Ferranti shows what an enormous waste exists in the use of coal in the multitude of small installations and household furnaces. The economies which could be obtained by the concentration of the generation of power in a few large central stations and the utilization of that power not only for the purpose of power supply, which is now common, but for all purposes for which coal is now utilized, would decrease the consumption in that country by sixty per cent. The great advantage which would result from this condition does not reside alone, however, in the saving of coal, but in the attendant saving of labor and in the utilization of the by-products of the coal for fertilization and other purposes. It is probable that we do not generally realize the immense amount of labor which is entailed, in those parts of our country using soft coal especially, by the general diffusion through the atmosphere of smoke. In many large office buildings a corps of cleaners is kept constantly at work removing the deposits of soot which this condition entails, and a large part of the outdoor cleaning, painting of buildings, etc., is due largely to its presence. The total expenditure for removing these effects in every large city must mount up into the millions of dollars.

But the most important attendant advantage in such a utilization of the coal would probably consist in the recovery of the fertilizer which would result from isolation and application of the nitrogen compounds which exist in the coal. This constituent of the coal represents a very small percentage of the total weight. Nevertheless when we con-

sider the enormous quantity of coal which is involved, the nitrogen products which can be recovered in the form of sulphate of ammonia would represent a very valuable asset to our farming interests. The utilization of this material on our agricultural land would serve to prevent the general degeneration in the quality of farm land which is at present so almost universal in this country. It would be well for us to consider more earnestly this question, and although we are not so concentrated as our English brethren and would probably have to deal with problems involving the transmission of energy over much longer distances, it would nevertheless seem that this is the ultimate ideal to which we should look forward.

It is encouraging to see that Mr. Ferranti does not regard this ideal as a thing hopelessly out of reach, but considers it as a condition towards which England must naturally grow. Mr. Ferranti has always been distinguished for his foresight and when a man of his type can look upon such a realization as a possibility in the near future, it behooves us in this country to consider whether such a thing is not also possible here and to make every endeavor to direct our progress in this direction. The conservationist should take hold of this matter with optimism and new courage on finding that such an authority as Mr. Ferranti does not consider these considerations as visionary and idle dreams.

One aspect of the conservation of coal which is not touched upon by Mr. Ferranti, but which is of vast importance in this country, relates to the utilization of the enormous deposits of lignites which are easily available. Over 150 million acres in the United States proper are underlain by beds of lignite and it is believed that about one-half of the coal beds of Alaska are of this description. This low-grade coal has been considered worthless for steaming purposes, but the use of a gas producer renders it available for power production, with such efficiency that it has been claimed that a ton of lignite utilized in the producer makes available more energy than a ton of high-grade coal burned under a boiler.

In North Dakota alone the Geological Survey reports lignite fields of an area several times as great as the coal fields of Pennsylvania. This brown lignite is being utilized for steaming purposes in the power plant of the Williston project by the Reclamation Service, a special furnace having been designed for this purpose. Favorable results are reported, and the fuel is being utilized with fair economy.

LAMP EFFICIENCY AND TEMPERATURE.

Attention was called in these columns last week to a simple experiment for demonstrating that a carbon filament is at a higher temperature than a tungsten filament, when burning at the same efficiency. From this it was argued that the metal filament must be radiating selectively, and relatively more intensely in the visible part of the spectrum, since otherwise it would have to be just as hot as the carbon.

Objection may be raised, and quite properly, to this deduction, on the ground that it is the apparent temperature (sometimes called "black-body temperature," or temperature which a black body must have to give the same optical effect), and not necessarily the true temperature, which is higher for the carbon. That is to say, if both materials gave spectral energy curves of the same shape, but with the intensity of radiation everywhere about three times as great for the carbon as for the metal filament, the observed result might be obtained with both filaments at the same real temperature. While this condition of affairs is most unlikely, and indeed may be shown to be not the case, its possibility makes the attempted demonstration inconclusive. Other proofs are at hand, however, which show conclusively that the radiation from the metal filaments is more selective than that from carbon, that is, their radiation is less like that of a black body. Among these are the experiments of Dr. W. W. Coblentz, cited last week, and those of Dr. E. P. Hyde, by entirely different methods, given in a paper presented to the Franklin Institute of Pennsylvania, and published in its *Journal* for June and July of this year.

Further confirmation is afforded by the experiments of Mr. W. E. Forsythe, reported in a paper presented at the recent meeting of the American Physical Society and abstracted in this issue. Measurements were made of the actual temperature and of the efficiency (candlepower per watt), and it is shown that for the same efficiency the carbon has the higher temperature, while for the same temperature the metal filaments give higher efficiency. When operating under rated conditions the metal filaments are at higher temperatures than the carbon filaments, so that the better commercial efficiencies are due in part to selective emission and in part to a higher working temperature. It is to be noted in these curves that tantalum shows better characteristics than tungsten, that is, higher efficiency at the same temperature or lower temperature for the same efficiency. This does not agree with the work of Hyde, which showed tungsten more selective than tantalum.

Mr. Forsythe presents another series of curves in which the efficiencies are taken as the ratios of the energies in the visible and the total spectrum. That these curves differ from those based upon photometric measurements is evidence that the eye is not equally affected by equal amounts of energy in the different parts of the spectrum, and furthermore that the distribution of energy from the several sources at the same temperature is not the same throughout the visible spectrum. That the sensibility of the eye varies with wave length is almost axiomatic and sensibility curves are well known. That the distribution of energy from the several sources is different, points once more to a difference in selectivity for the emitted radiation.

ORNAMENTAL STREET AND BOULEVARD LIGHTING.

That we have been deficient in both the quality and quantity of our public lighting of streets and boulevards has long been established by comparison with European standards. That we are making a brave effort to improve conditions is evident from the great number of ornamental lighting installations that have been made in our cities during the last few years. But it is also evident that we have made some mistakes in this direction, which is not surprising, however, in view of the youth of the movement for better lighting.

This movement for better and more attractive lighting has found its strongest expression in the almost countless installations of tungsten cluster lighting, particularly in the central and western cities of our country. It is in connection with such installations that frequent errors have been made. The most grievous one is the irregular spacing of the lights, due to leaving the matter almost entirely to the option of the owners or tenants of the buildings along the street. Most of the ornamental street lighting that has been done in this country has been through the initiative of the more enterprising merchants and of the lighting companies. These deserve great credit, for by their co-operation the pioneer work has been done. On the other hand, the public deserves censure for taking no active part in such a great public improvement. Its negligence is notoriously common.

Ornamental street lighting is not distinctively a private undertaking, such as electric sign lighting, which is almost exclusively for advertising purposes. The sidewalk is a part of the public street and should be kept free for the public's use. The only posts located along the curb-line should be for public-utility purposes, such as public lampposts, trolley poles, public guide posts, etc. The primary object of all street lighting is the illumination of the street, which is a public function and should be done at public expense. If, incidentally, by making it particularly attractive, it has an advertising value to the merchants or property owners of the street, they may justly be called upon to bear a part of the expense in proportion to that advertising value. This should be done by special assessment levied legally and equitably upon those benefited. Thus more funds become available for the improvement and it can be made more effective and beautiful.

As an example of what may be done when a public body takes proper hold of a lighting proposition is the new lighting of Michigan Bouelvard in Chicago, which is described on other pages of this issue. The distinctive design of the lighting is in conformity with the principles of illuminating engineering and the requirements of the artist. It is safe to say that if the ornamental lighting had been left to the property owners, the effect could not have been nearly as splendid.

MOTOR-DRIVE IN A TANNERY.

The ever-increasing number of industrial establishments installing electric generators, transmission systems and motors for driving and lighting in their plants is attracting much attention. The advantages of electric power over other systems is too well known to warrant argument. The flexibility, convenience and economy of electric drive are proven advantages which should make for its substitution in a great many existing steam plants and be given a place of prominence in the consideration of the equipment of contemplated plants.

On other pages of this issue there appears a description of an installation of electrical equipment in the tannery of the N. R. Allen's Sons Company, at Kenosha, Wis. When this company was considering the installation of electric motors for operating its machines, the many advantages offered by this method of drive were carefully considered. In an establishment the size of this tannery, which covers many acres, the distances to be traversed by transmission machinery are very great. Using steam power with the prime movers installed in a central location entails the use of long lines of shafting, together with heavy belts for transmitting power. It is evident that the losses in shaft bearings, slipping, etc., would be very great.

By the substitution of electric power in this plant, which formerly was supplied from three separate steam plants, it became possible to eliminate one-third of the shafting and one-third the belting formerly in use and it is estimated that the power loss in friction has been reduced two-thirds.

One of the chief sources of economy in employing electric power is the centralization of the sources of supply. A central power plant can be used where all the power is generated in large machines of high efficiency and under the supervision of a minimum number of attendants. Such a plant may be located in a position best suited for receiving fuel and water.

At the Allen tannery the generating equipment is divided between two of the old power houses which formerly housed the steam equipment. These are of a size which only permits the installation of a single unit in each. The local conditions here evidently did not favor a single generating station unless an entire reconstruction should be attempted. To obtain the economy of centralization would in this case require a much larger investment in the plant.

One advantage of decentralized power generation is the independence of the generating units. In case of fire or disabling accident in one station the other may then continue to operate, and carry at least a part of the load of the disabled station, thus avoiding a complete shutdown of the buildings supplied from the latter. In this case, no provision has been made for such a transfer of load, and it would seem worth while to connect the two systems at some point by power cables.

RECENT ELECTRICAL DISCOVERIES.

ADDRESS BEFORE CHICAGO ELECTRIC CLUB.

"Recent Electrical Discoveries" was chosen as the topic of a very interesting address delivered by Prof. Robert A. Millikan, of the University of Chicago, before the Chicago Electric Club, at the regular weekly meeting of that organization on Wednesday, November 23.

Before entering into a discussion of the recent discoveries in the electrical industry, Professor Millikan classified the men constituting the personnel of the industry into two divisions—one division comprising the men who carry on purely academic research work and the other division comprising the men who apply the results obtained by the former to commercial practice. Both of these divisions are closely allied, according to the speaker, who said that the men carrying out the research work strive for results regardless of the material benefits which might result while the men identified with the commercial end of the business had to cease their efforts when the dividends ceased. However, it is very frequently true that discoveries only open up new channels of thought which are at some later date developed to the state where they become of value from a commercial standpoint.

Professor Millikan then classified the most recent electrical discoveries, according to the academic rather than commercial value. The first mentioned was the discovery of electric waves by Hertz. This discovery resulted from ideas created by Maxwell and illustrated the point previously made by the speaker.

The second group of discoveries were those of the X-ray and radioactivity. The third was evidence brought to light in 1903 tending to prove that mechanics and electrodynamics were closely related. The fourth discovery discussed by the speaker was of the atomic structure of electricity. Professor Millikan stated that researches of the last four years tend to prove that electricity is something which is made up of elementary particles.

That these theories are true is clearly evidenced, according to the speaker, by experiments carried out in the laboratories of the University of Chicago. An account of these experiments was presented by the speaker in a paper read before the American Electrochemical Society at its meeting in Chicago last October. An abstract of this paper appeared in the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN for October 22.

In conclusion Professor Millikan stated that the elementary charge is a constant and that it is possible to account for the inertia of an electron by electromagnetic considerations. One significant result evidenced by the experiment carried on is that electricity has a granular structure.

Following the address of Professor Millikan brief remarks were made by Francis B. Badt, Prof. E. H. Freeman, Kempster B. Miller, Edward N. Lake and A. A. Gray.

At the meeting of the Club on Wednesday, November 16, Fletcher Dobyns delivered a very interesting and instructive address on "Lessons from the Recent Election." For the general improvement of political conditions Mr. Dobyns advocated, in addition to the already existing Australian ballot, direct primary act and general registration, a corrupt practices act, state-wide civil service and the initiative and referendum. A general discussion ensued which was taken part in by Thomas G. Grier, Donald M. Carter and Max W. Zabel.

Paris Suburban Lines to Electrify.

Electric traction is to be used on the western suburban lines running out of Paris, France, and the roads are to be rehabilitated.

The engineers of the West lines, which now belong to the Government, having been taken over by the latter quite recently, have drawn up a project which has considerable interest owing to the great amount of passenger traffic to be handled. They claim to be able to transform the whole of the west suburban system centering at the St. Lazare depot for about $20,000,000 and to make the proper accommodations at the depot itself for $2,000,000. This depot serves no less than 70,000,000 passengers yearly, in which the suburban traffic figures for 50,000,000, and this traffic increases regularly at the rate of a million a year.

Some of the suburban lines run a great number of trains per day; for instance, there are no less than 218 trains on the Versailles line and 213 on the St. Germain line. Such a great number is not absolutely necessary for the traffic. The steam trains are run at slow speed, from fifteen to thirty miles an hour, and 150 locomotives and 1,400 cars are needed. These, however, run empty or lightly loaded when at the middle or the end of the trip when in the suburbs. Statistics show that only eighteen or twenty per cent of the seats are occupied in the total trip, so that much useless rolling stock has to be transported. The great congestion of traffic in the lines starting from the depot through town is due to the fact that these lines, of which there are too few, lie in a lower level and between walls which cannot be moved.

The use of the zone system is one of the features of this electrification and it is claimed that for the same price there can be run three times the present number of train-miles. The trunk lines will have entirely separate tracks, according to the English method, and the suburban lines are to be separated into three zones. Each zone has separate trains which do not stop in the interior zones. Thus the number of trains will be reduced. A three-minute service like that used on the city subway will be adopted for the first part of the inner zone.

Indiana Trolley-Guard Investigation.

With a view to finding the exact state of affairs on the interurban railways and in order that it may arrive at some conclusion regarding the best type of trolley guard, the Indiana Railroad Commission has issued a set of questions to interurban railway managers.

The questions relate to the style and number of guards used and the number of protected and unprotected crossings. Inquiries are also made as to the opinion of each company regarding these devices. S.

Du Pont Subway Cars for Cleveland.

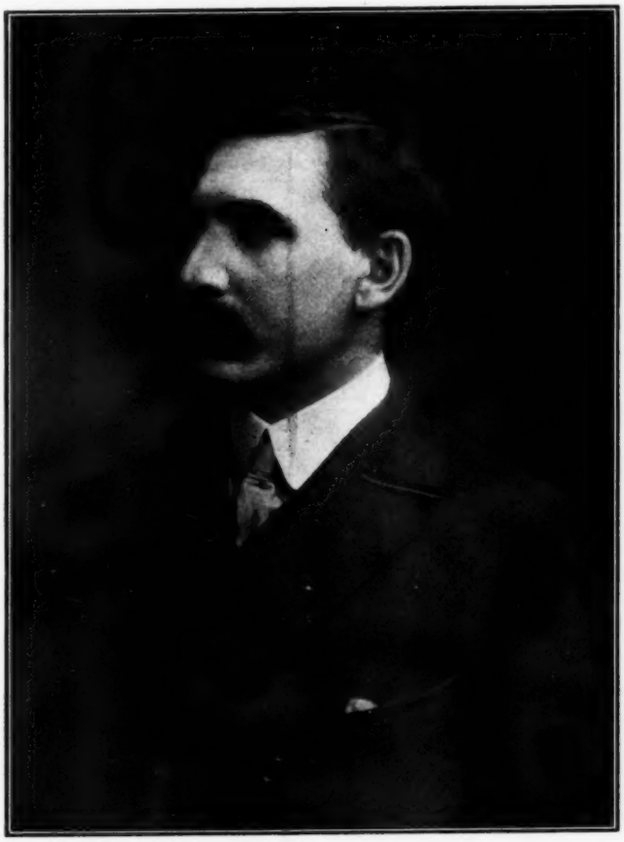
At the recent election in Cleveland, O., the city decided by a referendum vote to give a 75-year franchise for the operation of a subway system using the Du Pont car, described in the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN for September 24.

The franchise contains profit limitations and a provision for city ownership at the end of the term of years.

S. Z. de Ferranti.

The subject of this sketch, Sebastian Ziani de Ferranti, whose memorable presidential address delivered to the Institution of Electrical Engineers of Great Britain, on November 10, on the subject of the conservation of coal, and the incidental suggestions which are naturally brought to mind in summing up these questions of conservation, appears on other pages of this issue, is in many ways a remarkable man.

Mr. Ferranti was born at Liverpool, England, in 1864. He was educated at Hempstead School, St. Augustine's College, Ramsgate, and University College, London. At an early age Mr. Ferranti displayed capacity for machine design, and when between ten and twelve years old he produced original sketches which showed an extraordinary grasp of detail. He turned his attention to electrical engineering work about 1877, and while at Ramsgate designed among other electrical apparatus, an arc lamp very similar to the Brush clutch lamp. When fourteen years old he constructed his first dynamo, and this also bears a remarkable resemblance to the Brush machine, although Ferranti had never seen this apparatus. It seems hardly possible that one so youthful could have acquired so much information respecting the then little understood subject of electricity, but the chronicle is nevertheless true, and although Mr. Ferranti has shown remarkable qualifications in later years, his work as a boy stands out very prominently and almost epochal insofar as development in the electrical industry is concerned.



SEBASTIAN Z. DE FERRANTI,
President of the Institution of Electrical Engineers.

When he was fifteen years old, Mr. Ferranti began a twelve months' course at University College. Very soon after this he gained permission of the superintendent of the Kings Cross Electric Lighting Station, then operated by Crompton & Company, to go on the practical shifts with the men, and in this way he greatly stimulated his desire for this work, and added to his fund of information. He made his first practical working start, however, in the employment of Siemens Brothers & Company, at Woolwich, during the period when the Mackey-Bennett submarine cables were being made for the Commercial Company. Shortly after this experience, when seventeen years old, Mr. Ferranti was placed in charge of the erection and running of a temporary lighting plant at Wolverhampton. About the same time he made a series of experiments at Kings College on electric furnaces for Sir William Siemens, and later on conducted the initial tests on the secondary battery then being introduced in England by Mr. Faure. In short, Mr. Ferranti's career has been one of continual effort and achievement. The Ferranti rotary-field motor, the continuous-current meter, and the Thompson-Ferranti alternator are all historical evidences of this man's ingenuity.

About 1883, Sir Coutts Lindsay, president of the Grosvenor Gallery, decided to adopt the Gaulard and Gibbs transformer system of distribution, which was then coming into vogue. The system was highly successful, and led to the taking on of a considerable extension of the plant, and Mr. Ferranti was selected to engineer these extensions. The series system was changed into a parallel system, the Siemens alternators were rearranged, switchgear designed and erected, and measuring instruments introduced. The London Electric Supply Corporation succeeded the Grosvenor Gallery Company, and soon some 36,000 lamps were connected up, all supplied with current from machinery erected in basements of buildings adjacent to the gallery.

The extension of the service ultimately made expedient the construction of a new plant at Deptford. It was here that Mr. Ferranti carried out some notable ideas in installation, working in opposition to the regulations of the Board of Trade, and contrary to the opinions of the best informed electrical men of the day. The project at Deptford was designed to supply 2,000,000 lamps with 10,000 horsepower in generators, and a 10,000-volt distributing system. There were eight miles of distribution, with transformer stations built en route, stepping the current down to 2,400 volts. In spite of the almost insuparable difficulties and the entire lack of information in many directions, the work was carried out successfully, with Mr. Ferranti giving his personal attention to the most trivial details, and the accomplishment stands as a monument to his ability as a constructor.

Pennsylvania Station Opens.

The Pennsylvania station in New York was opened to the public on Sunday, November 27.

At the meeting of the Chicago Signal Club, Monday evening, November 28, the following subjects were discussed: "Shunt vs. Series," "Fouling Circuits for Switches" and "Protection Against Foreign Current."

Generation of Electricity in the Largest Steam-Driven Station.

At a meeting of the Lewis Institute Branch of the American Institute of Electrical Engineers, which was held on the evening of November 23, and attended by over 500 persons, W. L. Abbott, chief operating engineer of the Commonwealth Edison Company, delivered a very interesting illustrated lecture on "The Manufacture of Electricity in the Largest Steam-turbine Station in the World."

Mr. Abbott called attention to the rapid development and great importance of the central-station industry. The supply of electricity is now such an every-day matter that its generation is expected to be absolutely reliable at all times and the plants must be so designed as to meet every conceivable demand. He illustrated the character of the modern central station by citing the conditions at the greatest of them, the Fisk Street station of the Commonwealth Edison Company.

A modern power house such as this is largely a place in which coal may be handled, burned and its refuse disposed of in great quantites. Therefore, the facilities for storing, unloading, handling and burning of the coal form a very important feature of the entire equipment. At the Fisk Street plant, for instance, of the 300 operatives employed, nearly half are engaged in operating the apparatus which handles the coal. No manual labor is used in this connection. Cars are unloaded by merely opening the bottom, if the car is of the bottom-dump type, or by means of an overhead crane with a clamshell bucket, which has a capacity for scooping up two tons of coal at a time, and unloads a car at a cost of about two cents per ton. If the coal is of the lump variety, it is run through a motor-driven crusher, as the stokers are arranged for burning screenings and other fine coal.

The boilers are rated at 500 horsepower each, but ordinarily develop about 800 horsepower, and when running at this rate each consumes about two tons of coal per hour. At the Fisk Street plant there are eighty boilers. When working at normal capacity there is consumed in the entire station about two and one-half tons of coal per minute, evaporating about 1,700 tons of water, and discharging from the five stacks sixty-two tons of waste gases and heated air per minute.

After tracing the development of the steam turbine, Mr. Abbott showed that this type of prime mover has practically replaced the steam engine for all large-capacity service such a modern power plant requires. He described the action of the Curtis turbines used in the plant under discussion, calling particular attention to the great weight of the vertical shaft, which is about seventy-five tons, and is supported upon oil step bearings.

Taking up the generator, Mr. Abbott analyzed its function and showed how the switchboard operator controls not only the action of the generators, but also the multitude of oil switches

THEODORE N. VAIL.

which are associated with the various transmission lines. He illustrated very clearly the enormous power in one of these generating units and the disastrous consequences of a short circuit on the machine.

In conclusion he called attention to some interesting data of the Commonwealth Edison Company's business as being typical of what the modern central-station industry represents. The total investment is $68,000,000, the pay roll is $6,000 a day, coal bill is $3,700 a day, taxation and special compensation to government bodies amount to $3,000 a day. There is annually added to the capital investment for increase of plant from $6,000,000 to $7,000,000. As the rates of the current supply are steadily going down, the need for efficiency in generation and reduction of operating costs and other charges becomes greater.

Theodore N. Vail Made President of the Western Union Telegraph Company.

Col. Robert C. Clowry, president of the Western Union Telegraph Company, has tendered his resignation to the board of directors, and Theodore N. Vail, president of the American Telephone & Telegraph Company, which controls the Western Union, has been appointed to fill the vacancy.

Mr. Vail was one of the active spirits in Washington, D. C., with Professor Bell and Gardner Hubbard who developed the telephone industry. For several years he was interested in the early organization of the telephone business, and as general manager of the American Bell Telephone Company he laid out the plans for the permanent organization. He gave up active participation in the telephone business to become engaged in railway and electrical enterprises in Europe and South America. He inaugurated the street-railway system of Buenos Aires, and developed power-transmission service in neighboring states. These enterprises being carried to a high degree of success, he disposed of his interests to South American and European capitalists in 1907, when he became president of the American Telephone & Telegraph Company.

When plans for the control of the Western Union Telegraph Company by the American Telephone & Telegraph Company were consummated over a year ago, Mr. Vail announced that the "object of the acquisition of the stock of the Western Union was to increase efficiency which would mean cheaper service." This policy has been materially carried out, as is evidenced by the inauguration of "night lettergrams," co-operation between telephone and telegraph stations for expediting of service, and a general improvement in the handling of both telephone and telegraph traffic.

Colonel Clowry became president of the Western Union Telegraph Company upon the retirement of Gen. Thomas T. Eckert on March 12, 1902. He started at the lowest step of the telegraph business fifty years ago as a messenger, and graduated to the key by his alertness and skill in doing things well. He rose by successive steps to occupy the position of vice-president, from which he was elected to the presidency. He will continue as a director and a member of the executive committee.

Electricity in the Tanning Industry.

Description of the Electrical Installation in a Large Tannery at Kenosha, Wis.

An installation of electrical equipment in an industrial establishment that is of more than passing interest has recently been completed at Kenosha, Wis., in the large sole and harness leather tannery of the N. R. Allen's Sons Company.

The Allen tannery, said to be the largest of its character in the country, comprises a group of twenty-three buildings covering an area of many acres. As the average height of the building is three stories some idea of the size of this plant may be gained.

When the Allen Company was considering the proposition of electric drive, the many advantages offered by this method of power transmission were carefully studied. In an establishment the size of the Allen tannery the distances to be traversed by transmission machinery are very great. If the prime movers are located in a central position it is necessary to use long lines of shafting together with heavy belts for transmitting power. The losses in the shaft bearings and in the slip of belts are very great.

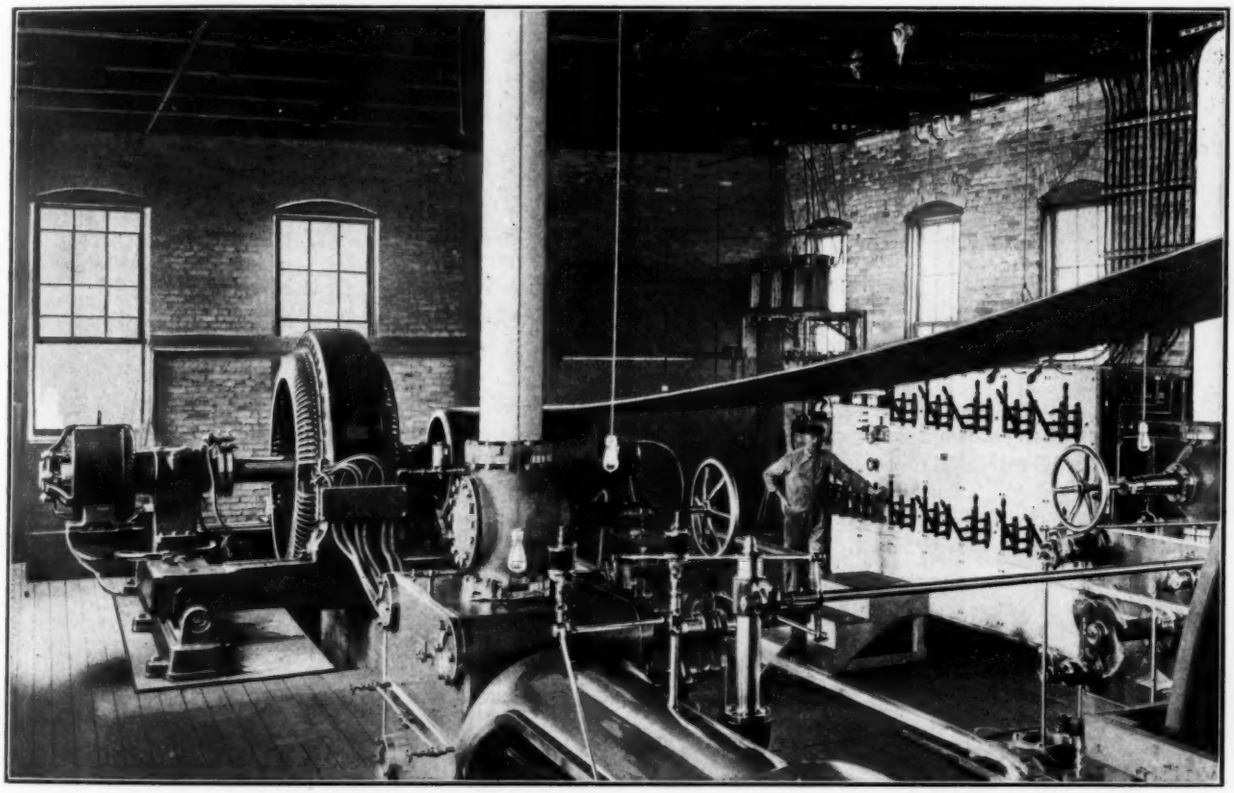
Realizing these points, the Allen Company some time ago began changing the method of driving its machinery from that of separate engines and shafting to a central generating station with electric transmission to motors. In some places these motors drive individual machines and in other cases drive groups of machines. As most tannery apparatus operates at comparatively slow speed it is usually necessary to belt from the motor to the machine or groups of machines driven, and this method has been employed at the Allen tannery.

The buildings of the tannery of the N. R. Allen's Sons Company may be said to be divided into three general groups. The northern and southern groups are equipped for tanning harness leather, while the central group is equipped for tanning sole leather. The northern and central groups of buildings are provided with electric power, while the machinery in the southern group is still driven by means of separate engines and shafting.

Generating equipment for supplying power to the motors in the various buildings comprising the central and northern groups is divided between two of the old power houses.

Power plant No. 1, which furnishes current for the buildings in which harness leather is tanned contains a 2,405-ampere, 240-volt, sixty-cycle three-phase alternator belt driven by a 24 by 48 Wheellock twin engine. This engine was originally one of those used in the South Side cable railway in Chicago, the flywheel being grooved for rope drive. Two cables drive from this engine to a small exciter. The leads from the alternator are connected to a two-panel switchboard equipped. with suitable measuring instruments. Connections are made from this board to the main board controlling the feeder circuits in Plant No. 2.

Steam is supplied by a battery of



GENERAL VIEW OF ONE OF THE POWER PLANTS, ALLEN TANNERY, KENOSHA, WIS.

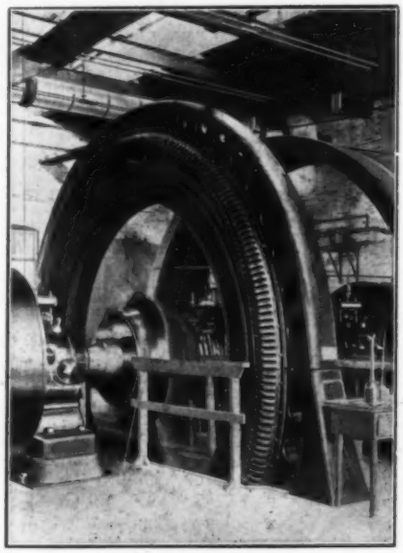
three Wickes water-tube boilers, each of which is rated at 400 horsepower. The furnaces are each equipped with automatic stokers, which are operated by means of a steam engine located adjacent to the boilers. Ashes are automatically dumped in the basement of the boiler house, where they are collected and hoisted by means of motor-operated ash hoist to the second-floor level, to be dumped into railway cars. The motor driving the ash hoist is of ten-horsepower size.

The generating equipment of Plant No. 2, which furnishes power for the central group of buildings, comprises a 1,445-ampere, 240-volt, sixty-cycle, three-phase alternator driven by an Allis-Chalmers Corliss engine. Excitation for this alternator is provided by a small direct-current generator mounted on the end of the alternator shaft.

The steam generating equipment consists of ten 125-horsepower Freeman boilers. As in Plant No. 1, these boilers are also equipped with mechanical stokers operated by a steam engine. In this plant a large share of the fuel used is the refuse bark taken from the leaches in the leach house. This material is conveyed by means of a motor-operated belt conveyor to the top of the boiler house where it is discharged directly in front of the stokers.

A view of the interior of the generating room of Plant No. 2 is shown in one of the accompanying illustrations. The switchboard is located adjacent to the generating unit. It controls all the circuits to the various buildings supplied by both alternators and is equipped with standard switches and measuring instruments. Practically all wiring about the plant is overhead.

The water supply, always a vital factor in tannery operation, is partially supplied from a river, five blocks distant, by automatic pumps, supplying 1,500 gallons per minute, and bringing it to the power plant, thence to a central reservoir from which it is distributed to the various tannery departments, almost entirely by gravity pressure. The two centrifugal pumps are operated by a fifty-horsepower and a sixty-horsepower motor respectively. These are controlled by automatic switches and remote-control apparatus located on the switchboard.



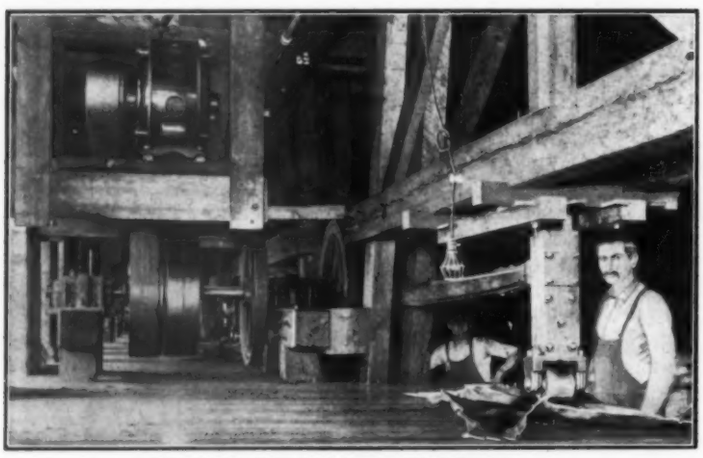
VIEW OF ALTERNATOR IN POWER PLANT, ALLEN TANNERY.

Preparing the tanning liquor is the fundamental process in tanning. The bark mill and leach house in which this operation is carried on at the Allen tannery is equipped throughout for electric drive. Bark entering the bark mill is passed through two Ott mills, where it is ground and then conveyed, by means of a double-chain conveyor from the mill-room to the leach house. These two mills, which are operated by a 125-horsepower motor, supply twenty 14 by 16 foot leaches. The conveyor, operated by a fifteen-horsepower motor, on its return trip, carries the spent tan from these leaches to an elevator that in turn conveys the spent tan to the boiler house. This latter conveyor is operated by a ten-horsepower motor.

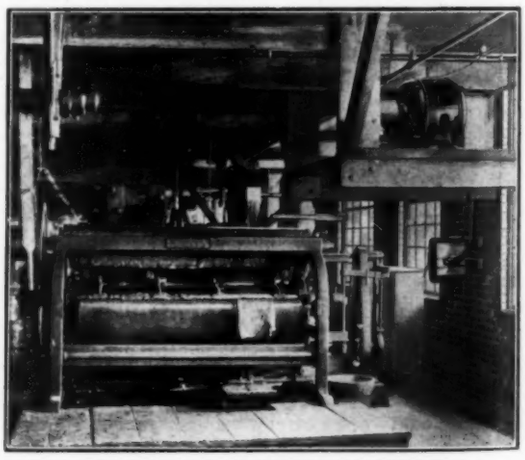
In leach pitching the utilization of electricity has permitted a remarkable saving in shafting, cost of other mechanical equipment and reduced the operating cost.

There is also installed in the leach house a motor-driven air compressor for supplying compressed air for handling the tan liquor. The motor driving this compressor is of twenty-horsepower size.

In tanning harness leather the first process, after soaking the hide in a lime solution, is to remove the hair and any particles of flesh which may still be present. These operations are carried on in a building known as the beam house, in which is installed an unhairing machine, driven by a ten-horsepower motor, a wash and bate wheel, driven by a fifteen-horsepower motor, and a lime reel, driven by a fifteen-horsepower motor. The hides after passing through the unhairing machine are placed in the wash and bate wheel where they are thoroughly washed. To guard against any lime remaining in the hide, they are then passed through the motor-driven lime reels. In the beam house some conception of



MOTOR-DRIVEN ROLLING MACHINES.



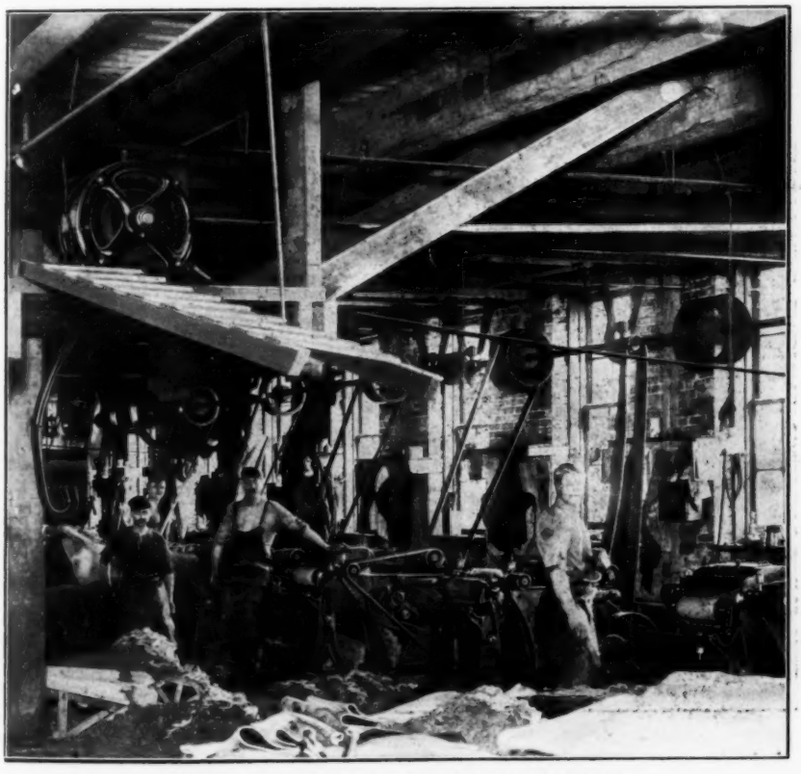
MOTOR-DRIVEN SETTING MACHINE.

the work done may be gained from the unhairing machine which unhairs over 450 hides daily. For drying the hides after they pass through the beam

MOTOR-DRIVEN JACKS.

house operations, there is installed a ventilating fan operated by a five-horsepower motor.

Leaving the beam house the hides



MOTOR-DRIVEN LEATHER SHAVING MACHINES.

pass through the tan yard where they are again washed by means of a wash wheel driven by a five-horsepower motor.

After leaving the tanning vats, where they are next placed, the hides are taken to the shaving department where they are trimmed and then scoured. The equipment of this department comprises two shaving machines, each operated by a twenty-horsepower motor, and a scouring machine, also driven by a twenty-horsepower motor. The fifty-horsepower motor for operating the elevator of the building is also installed in this department.

From this department the hides are taken to the stuffing room where they are treated with grease and then dried. In operating machinery for stuffing leather tanners recognize the necessity of uniform speed because of the uniform pressure required. The stuffing mill in the Allen tannery is motor-driven, a fifty-horsepower motor being employed. For drying the hides after passing through the stuffing mill a motor-operated fan is employed. This fan is driven by a ten-horsepower motor and operates continuously day and night.

The next operation in preparing the tanned hide for the market, in which electrically operated machines are used, takes place on the setting floor. The hides after leaving the stuffing room are passed through setting machines to smooth the surface and fill any porous

ELEVATOR MOTOR.

places in the hide. Three setting machines are installed in the Allen tannery, a twenty-horsepower motor driving a line shaft to which the machines are belted. Following this operation the hides are again dried, air being furnished by a fifty-horsepower-motor-driven ventilating fan.

Blacking the hair side of the hide is the next operation. This is a manual process, upon the completion of which the hides are passed through jacks. The function of these jacks is to smooth the hide and force the black into all the pores. In the blacking department there is a battery of three jacks operated by a ten-horsepower motor. After jacking, the hides are allowed to dry, forced air being supplied in the drying room by a motor-driven fan. The motor is of fifteen-horsepower size and is belted to the fan.

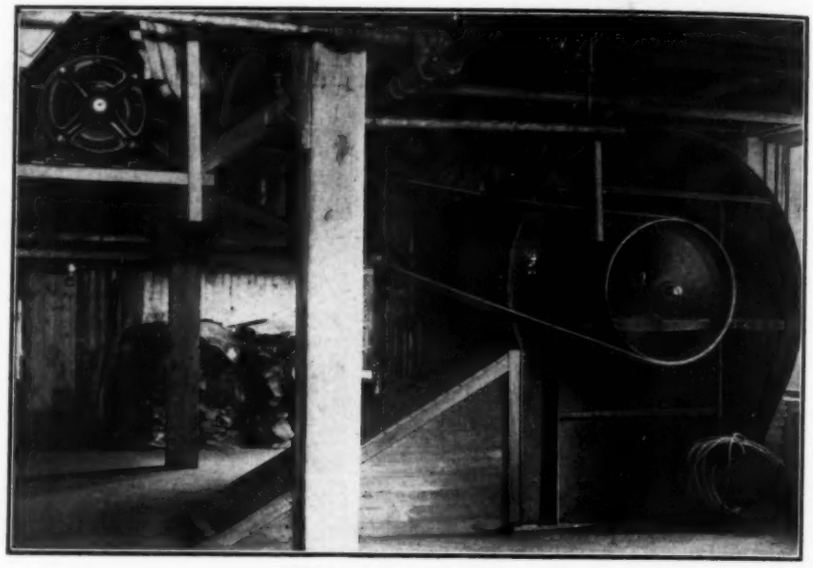
The finishing process is the last stage of the process of preparing harness leather. In this department at the Allen tannery there is installed a ventilating fan driven by a fifteen-horsepower motor, a conveyor operated by a fifteen-horsepower motor, two jacks driven by twenty-horsepower motors, and a ten-horsepower motor which operates an electric elevator.

For tanning sole leather the process is much simplified. The preliminary operations are practically identical with those employed in tanning harness leather. After the hides are scoured after tanning they are taken to the extract department, where they pass through motor-operated wringers, oil wheels and extract wheels. There are two wringers in this department, each belted to a shaft which is driven by a forty-horsepower motor. To oil the hides they are placed into large oil wheels operated by a forty-horsepower motor and from there they are placed into extract tubs. These tubs revolving at a high rate of speed force the extract into the hides making them practically waterproof and giving them added weight and thickness. A seventy-five-horsepower motor operates the two extract wheels employed in this department.

From this department the hides are taken to the finishing department in which is installed a stamping and cutting machine, four rolling machines and a motor-driven fan. The motors which drive the two elevators in this building are also installed in the finishing department. After being thoroughly dried, the hides from the extract department are trimmed on the stamping and cutting machine, which is driven by a five-horsepower motor, and then placed on the rolling machines. There are three rolling machines, operated as follows: One operated by a thirty-horsepower motor, and two by twenty-horsepower motors. These machines smooth out the hides and they are then ready for shipment.

An auxiliary department in the Allen tannery is the skirting department in which is installed fifty horsepower in motors, a ten-horsepower motor driving brush machines, a thirty-horsepower motor driving extract wheels and a ten-horsepower motor driving a ventilating fan.

In the basement of the office building there is installed a carpenter shop equipped to take care of the needs of the plant. In this shop there is located a thirty-horsepower motor driving a line shaft to which the various machines and tools ordinarily used are belted.



MOTOR-DRIVEN FAN.

The entire plant, including the steam-operated section, is electrically lighted, various sizes of incandescent lamps being employed. The voltage of the lighting circuits is also 240.

MOTOR DRIVING EXTRACT WHEELS.

All motors throughout the shops and the two alternators were supplied by the Allis-Chalmers Company, Milwaukee, Wis. The motors in the Allen tannery are all induction motors of the squirrel-cage type.

Copper Consumption Increases.

According to a recent statement published in the *Wall Street Journal*, the copper consumption, based upon the increase in the gross business of the electrical companies will show an unparalleled increase, whereas there has been only a small increase in copper production.

The General Electric Company, the Westinghouse Electric & Manufacturing Company, Western Electric and Allis-Chalmers Company, four of the largest consumers of copper in the world, show an increase in gross sales averaging more than twenty per cent.

THE 1910 EDISON STORAGE BATTERY.[1]

BY WALTER E. HOLLAND.

The above title refers to the "A" type Edison battery, which was actually brought out in 1908, and which, with slight improvements, is now being manufactured in large quantities at the factory in Orange, N. J. As this battery has been fully described in previous publications, no time will be given to further descriptions here, except to say that at present five sizes of cell are being marketed: "A4," "A6" and "A8" for automobiles, street cars, car-lighting, industrial engines, and so forth; and "B2" and "B4," small cells rated at forty and eighty ampere-hours, respectively, for ignition and other light work.

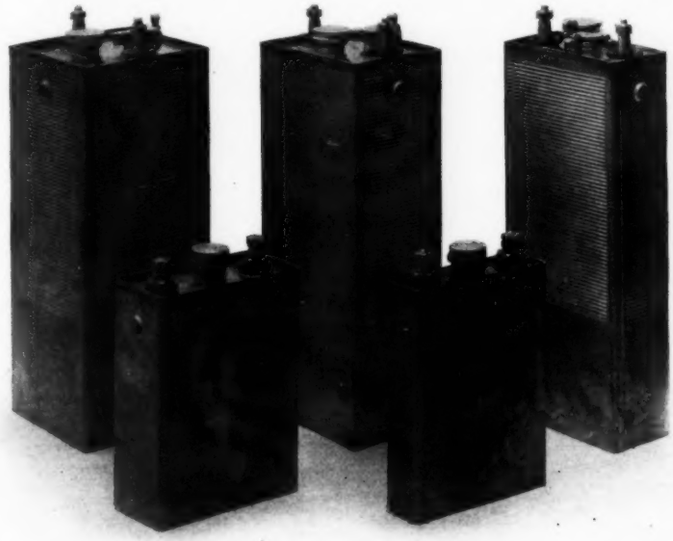


FIG. 1.—THE FIVE SIZES OF EDISON STORAGE BATTERY.

Fig. 1 shows a view of these various cells, and the following table gives ratings of the vehicle sizes, which interest us more particularly here:

	— Ratings of Edison Storage Batteries. —		
	"A4	"A6"	"A8"
Weight of complete single cell in pounds.....	13.34	19.00	25.00
Pounds per cell of a standard assembled battery	14.21	20.09	26.15
Normal discharge rate in amperes	30	45	60
Average voltage at normal rate	1.2	1.2	1.2
Rated ampere-hour output	150	225	300
Rated watt-hour output..	180	270	360

Before proceeding with the presentation of results of tests, which is the purpose of this paper, a few words are necessary regarding methods and testing arrangements.

The battery testing department of the Edison Laboratory is run twenty-four hours daily, and tests are made consecutively with very little rest between. Consequently the results are conservative, it having been found by experiment that slightly higher results are obtained if cells, after discharge, are allowed to stand long enough to cool, thus also allowing the electrolyte to equalize in the plate pores by diffusion. Cells are usually tested in groups of three or four and the average result taken; but sometimes when readings must be gotten quickly or at very frequent intervals a single cell is used in order to attain a higher degree of accuracy. In the latter case the test is always repeated on at least one other cell. Of course, no single cycle of charge and discharge is relied upon as being true, but the cycle is always repeated several times, or at least until the result becomes constant.

Innumerable repetitions of tests have shown that the cells as commercially manufactured have surprisingly uniform capacity and that under any similar conditions, no matter how abnormal, different cells will give practically identical results. The same characteristic of constancy of behavior applies also to the different sizes of cells, and at comparative rates they have similar characteristics, except for inconsequential variations in heating due to differences of radiating surface.

In work with the Edison battery the necessity of some reliable and convenient method of analyzing voltage curves, to determine which electrode was limiting the capacity or causing changes of voltage, was early appreciated. The author has devised several successful ways of attaining this end. The best scheme devised—one which has been used many years at the Edison Laboratory and has been successfully applied to various kinds of battery, including the lead storage battery—may be described in general terms as follows: The use as a third electrode of a partially reduced oxide which will undergo electrolytic oxidation or reduction in the given electrolyte without polarization. That the oxide should also be insoluble in the electrolyte is of course highly desirable, as its use cannot then contaminate the cell in any way. The oxide must be mounted in a suitable conductive support, and the electrode is preferably incased in perforated hard rubber, so that it may be rested on the plate tops with impunity. For the common electrolytes substances fulfilling the above requirements are numerous, but those which the author has found best adapted to use are: lead peroxide for sulphuric acid batteries, and either cupric oxide or the high nickel oxide of a charged Edison positive for all alkaline batteries.

Test electrodes of nickel peroxide and lead peroxide are best made from portions of positive plate of the respective batteries in which they are used. Connection should be made to each by metal of the same kind as that used for support of the active material, and perforated rubber insulation should be provided. These electrodes are prepared for use by fully charging and partially discharging them. They should also be "seasoned" by standing in electrolyte.

Test electrodes of nickel peroxide and of lead peroxide have been found to give excellent results in tests of the Edison and the lead battery, respectively, and have the advantage of being indigenous to those batteries so that no foreign substance is introduced. Peroxide of lead also has the advantage over cadmium of not requiring so much care to keep in condition; its properties do not seem to be affected, even by a drying-out in the air.

Fig. 2 shows a normal rate discharge of an Edison cell with independent curves of the electrodes taken by means of a nickel-oxide test electrode.

[1] Abstract of a paper read at the annual convention of the Association of Edison Illuminating Companies at Frontenac, N. Y., September 6, 1910.

The fixing of the normal charge and discharge rates and normal length of charge of the Edison battery is mostly arbitrary. The current rates given as "normal" in the table were determined by a careful consideration of the factors of I^2R loss in cell and the resultant heating, of time rates of charge and discharge, and of output; and were presumed to strike the best balance between the governing factors to suit the conditions of vehicle practice. Seven hours is taken as the normal length of a charge at normal rate simply because at this point the output and efficiency were judged to be in the best relation for average practice. These ratings are not obligatory, but the length of charge may be varied between zero and infinity as desired, and *should* be varied according to the output required in any particular service. The rates of charge and discharge are optional also when just two points are kept in mind. The first is that very low charge rates will not completely reduce—that is charge—the iron element, and the resultant discharge will be anomalous as to voltage. No permanent injury has ever been known to come from low-rate charging, and the discharge will usually recover normal characteristics when the cell is again worked regularly at normal rate. If not, then overcharging at normal rate and discharging to complete exhaustion will certainly re-establish normal conditions. Secondly, it should be kept in mind that although excessive heating does no immediately-apparent harm to the battery, continuous working at high temperature will have an injurious effect tending to shorten its life.

The output of an Edison cell is determined by the capacity of the positive or nickel electrode, as the individual electrode curves of Fig. 2 show. It is found best in every way to design the cell with a sufficient allowance of iron active material to give considerable excess capacity to the negative electrode.

Cells do not have as high capacity when new as after some weeks of use. The betterment comes from an improvement of conditions in the nickel electrode which is brought about by regular charging and discharging. Overcharging expedites this self-formation and is recommended. Every cell manufactured is given three overcharge runs before leaving the factory, and this is always sufficient to bring the capacity up at least to the rating. The accretion of capacity continues for twenty, or more, runs, and no results can be considered typical which are obtained in tests made earlier than the twentieth run. The term "run" is used to mean a full charge and complete discharge.

The output and efficiency of a cell, working at ordinary temperatures, depend upon three factors—the rate of charge, the amount of charge, and the rate of discharge. Fig. 3 shows the relation of current output to current input when a cell is given different lengths of charges at two-thirds, one, and one and one-third times normal rate. It will be seen that for low inputs the efficiency is very high and practically the same for the different rates of charge. Further along the curves separate, the advantage being in favor of low-rate charging. Notice that the point taken as the normal input comes pretty close to the sharpest part of the bend.

The relations of current and energy output and of current and energy efficiency to the length of charge at normal rate are summarized in the curves of Fig. 4. These curves show maximum efficiencies on short charge of nearly ninety-nine per cent in ampere-hours and seventy-five per cent in watt-hours,

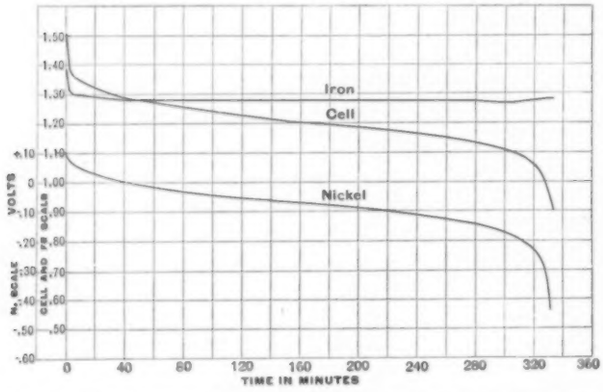


FIG. 2.—CELL VOLTAGE AND READING OF EACH ELECTRODE TO A NICKEL OXIDE TEST ELECTRODE.

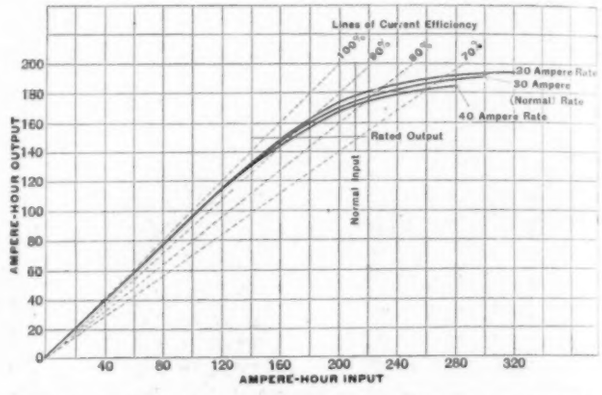


FIG. 3.—RELATION OF AMPERE-HOUR OUTPUT AT NORMAL RATE TO AMPERE-HOUR INPUT AT VARIOUS RATES.

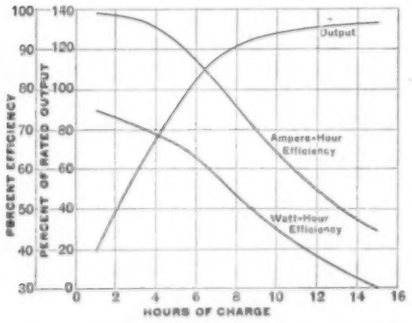


FIG. 4.—TYPICAL OUTPUT AND EFFICIENCY CURVES FOR DIFFERENT LENGTHS OF CHARGE AT NORMAL RATE.

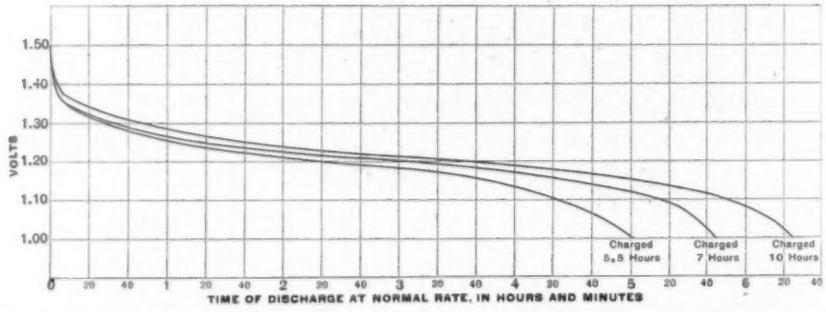


FIG. 5.—CHARACTERISTIC DISCHARGE CURVES OF CELLS WHEN CHARGED TO GIVE RATED, NORMAL AND OVERCHARGE OUTPUTS, RESPECTIVELY.

while on normal seven-hour charge the efficiencies are respectively eighty-two and fifty-eight per cent. It is often found advantageous (and economical, too) to work the battery at the lower efficiencies of a nine or ten-hour charge, thus realizing exceedingly high output results.

Watt-hour efficiency is the product of ampere-hour efficiency and "volt efficiency"—the latter term being used synonymously with the term "coefficient of drop" to express the relation of the average voltage of discharge to the average voltage of charge. The volt efficiency depends principally on the rates of charge and discharge and does not vary much under ordinary conditions. Charging and discharging at normal rate, its value will be close to seventy-two per cent for any length of charge not extremely short or long; and this figure therefore represents the practical limit of watt-hour efficiency for normal-rate working. The watt-hour efficiency on any normal-rate test may be calculated accurately enough for all practical purposes by taking seventy-two per cent of the easily-determined ampere-hour efficiency. Decreasing the current rate increases the volt efficiency, thus raising the limit of possible watt-hour efficiency.

The Edison cell has an air-tight cover, a valve being provided for the escape of gas. Practically no water is lost by evaporation, therefore, and a battery can be left idle for months without attention and there will be no danger of the solution getting low. Water is lost when a battery is working, however, and this results entirely from overcharging; for any current which is not used to effect the chemical changes at the electrodes goes to produce hydrogen and oxygen, the elements of water, which are emitted as gas. To replace this loss, pure water must from time to time be added. The figure of ampere-hour efficiency represents the proportion of a charge which goes to produce the desired chemical changes at the electrodes, therefore the balance is proportional to the loss of water. This points to the possibility of reducing the amount of required filling to almost nothing in those cases where a battery can be worked on short frequent charges at high efficiency.

Fig. 5 shows characteristic discharge curves for a cell at its rated output, at its normal output and at its overcharge output. Note that only five and one-half hours' charge at normal rate is required to obtain the rated output, and the efficiency under these conditions is very high; while under the overcharge conditions exceedingly high output per unit-weight of battery is realized at a sacrifice of efficiency.

Although in most of the tests presented here the cells were charged at constant current, this was done only for the sake of convenience; and in practice it is really better to "taper" the rate in the familiar manner of charging lead batteries. This is of especial advantage where the time on hand for charging is limited. Fig. 6 shows the result when the normal input of a seven-hour charge is put in in five hours, by using higher rates early in the charge. The results are practically as good as in the case of the seven-hour charge.

Constant-current discharges of the Edison battery at no matter what rate are found to give a quite constant output figure if carried to very low voltage (see Fig. 7), and differ only as to average voltage, this being higher or lower according as the $I\,R$ drop in the cell (depending on the I value) is little or

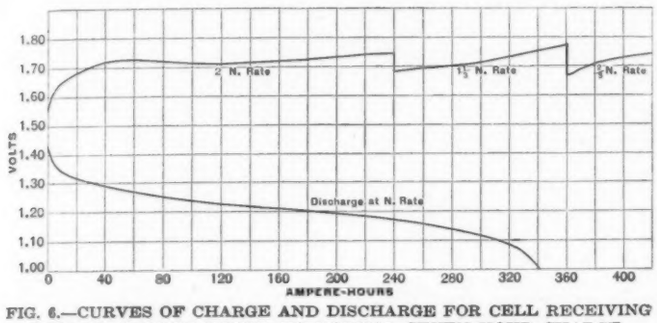


FIG. 6.—CURVES OF CHARGE AND DISCHARGE FOR CELL RECEIVING SPECIAL CHARGE EQUAL TO NORMAL SEVEN-HOUR CHARGE.

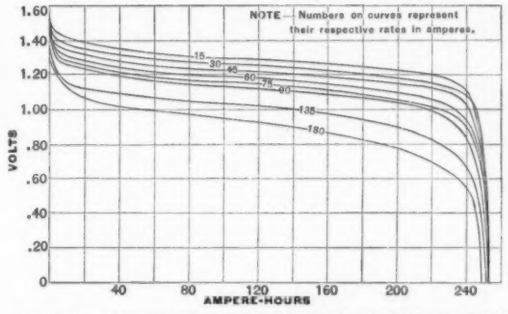


FIG. 7.—CONSTANT-CURRENT DISCHARGES TO ZERO VOLTAGE AT VARIOUS RATES.

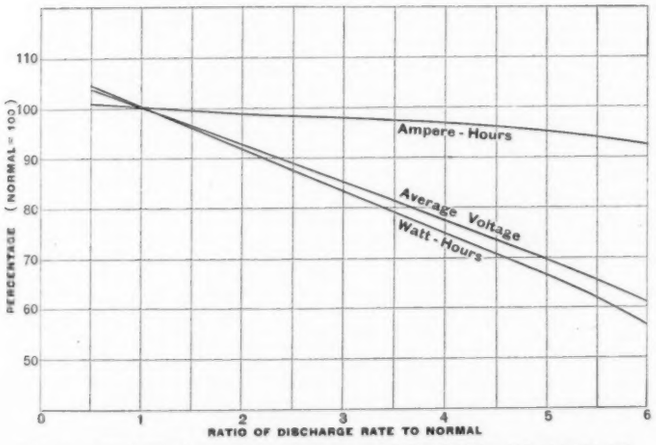


FIG. 8.—RELATION OF OUTPUT CHARACTERISTICS TO RATE OF DISCHARGE.

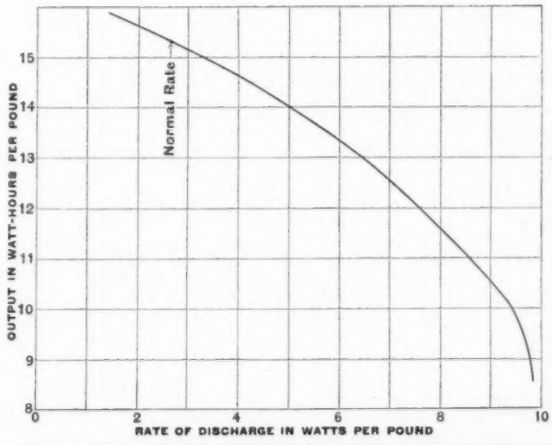


FIG. 9.—OUTPUT AT DIFFERENT DISCHARGE RATES IN RELATION TO WEIGHT.

much. The low-voltage part of the curve cannot be considered useful, however; so the statement sometimes made that the ampere-hour output of the Edison battery is independent of the discharge rate is not strictly true. On the other hand, it would not be a fair test to terminate high-rate discharge at 1.0 volt or 0.9 volt, as is done usually in normal-rate tests, because this would not correspond to the same state of discharge; and the cell would start the next charge in a semi-charged condition, which would make the subsequent discharge abnormal. Also, it is possible to discharge at a rate so high that the very first voltage reading will be lower in value than the above-mentioned regular terminating voltages. The author believes the fairest plan in this case is to discharge to successively lower voltage points as the rate is increased, each terminating voltage to be lower than the previous one by a value corresponding to the average increase of $I\,R$ drop in the cell resulting from the increase of current. If this plan be followed the amount of change of voltage from the beginning to the end of discharge will be practically equal at all rates, and the cell will be taken to a corresponding state of discharge each time. From a series of tests made according to the above plan, it will be seen that the ampere-hour output now decreases very slightly as the discharge rate is increased, but, as before, most of the loss is a voltage loss. The variation of ampere-hour output, average voltage, and watt-hour output with discharge rate is shown in Fig. 8, where normal values of these are each taken as 100 per cent.

In judging of the relative merits of storage batteries of different classes there are two appropriate bases of comparison as to output—the basis of weight and the basis of volume. In all non-stationary service such as automobile or car propulsion, car-lighting and so forth, high output per unit weight of battery is all important, while the space which a battery occupies, if not ridiculously great, matters little, amounting to a question of vehicle design. In Fig. 9 is given the energy output at different rates of power delivery calculated for one pound of Edison battery. The figures are based on the total weight and maximum volume—that is, the required volume of battery compartment—of a battery of a standard number of cells.

The effects of changes of temperature on the behavior of a storage battery are so varied and numerous that a book could be written on this subject alone. Many tests of the Edison battery have been made to determine these effects and an extensive series of temperature tests is now being carried on at the Edison Laboratory; but the subject can merely be touched upon here, and later, in all probability, an entire paper will be devoted to it.

So far, it has been determined that, in general, the cooler a battery is kept the longer will be its life; and that heat during charge is more detrimental than heat during discharge. As regards immediate output, the highest results are obtained by charging cool—say at a cell temperature of 75 to 85 degrees Fahrenheit—and discharging hot, that is, at 120 to 130 degrees cell temperature. The output will be reduced if charging is done at a cell temperature of less than fifty degrees, or more than 105 degrees, or if a battery is cooled to a low temperature during discharge. The Edison battery appears to be affected in about the same degree as the lead battery by low temperatures, and the salvation of both in cold wether lies in the fact that they are self-warming. It is a providential arrangement that the internal resistance of a cell becomes greater as the temperature decreases, because on this account the generation of heat within a battery is greatest when the battery is cold and automatically decreases as its temperature rises.

An interesting but not at all surprising characteristic of the Edison battery, which probably is common to storage batteries in general, is the fact that the rate of loss of charge during idleness varies with the temperature at which it stands, the loss being slight in the cold and greater as the temperature increases.

The sturdiness of the Edison battery has often been summed up in the statement that it is "fool-proof." And so it is,—but there are idiots! Therefore the Company does not feature this quality, but rather insists on careful handling of the battery at all times. Nevertheless, we have made many "fool" tests for our own satisfaction, and there can be no harm in giving the results of some of these to sensible men.

It has been shown that no injury results from connecting up a discharged cell with the polarity reversed and charging in the reverse direction.

Contrary to all reason and theory, it has been demonstrated that even carelessness in regard to keeping the plates covered with solution does no immediate damage to a cell. However, this should not be taken to mean that such treatment if persisted in would not ultimately do harm.

In one case, the cell was discharged, then emptied of solution and afterward was left for two weeks with its filling aperture open. This permitted of enough air getting in to discharge the reserve capacity of the iron electrode by direct chemical oxidation, and consequently it had to be built up again before the cell gave a normal discharge curve. It took five normal-charge runs to do this, but could have been accomplished at once, it has been found in other instances, by giving a long overcharge.

The damage done to lead cells by sulphation through standing wholly or partially discharged is well known, and when such a battery must remain out of commission for some time it is necessary either to give it freshening charges at frequent intervals, or else to give it a complicated shelving treatment involving much labor and trouble. The Edison battery can be set aside and forgotten in any state of charge or discharge for a practically unlimited length of time without fear of injury.

The Edison cell thrives on short-circuit discharges. Some consecutive short-circuit discharges show an actual betterment of the cell by such treatment. This betterment has been found to be due to the fact that high-rate discharges improve the working conditions of the iron electrode, giving the cell stronger voltage. The improvement is hardly great enough to show on a normal-rate discharge, but becomes evident at high rates.

The duration of usefulness of the new-type Edison battery must still remain a conjecture, sufficient time not having yet elapsed since its inception to ascertain this by actual service tests. Life tests have been made in the laboratory, however, under conditions designed to accelerate deterioration; and by comparison and inference some sort of an estimate can be formed from the results of these.

To get life results more quickly use is made of two principles, one, that high-temperature working shortens life; the other, that discharging to zero voltage, practiced continually, has a similar effect.

All ideas as to improvement of the storage battery are first tried out in miniature cells having the single iron pocket and single nickel tube as electrode units. These experimental cells are just like the commercial cells in mechanical construction and give comparative results at proportional rates. A relatively quick life test is obtained by maintaining such cells at a temperature of 130 degrees Fahrenheit during both charge and discharge, and carrying every discharge to zero voltage. After every fifty such "hot runs" each group of cells is allowed to cool down, and is then tested at normal temperature. It is certain that this "killing test" is at least three and perhaps five times as severe as the conditions of commercial service; that is, 50 hot runs would be equivalent in effect to 150 to 250 runs in practice. Nevertheless, miniature regular cells will increase in capacity during 150 to 200 hot runs, and at the end of 500 hot runs will usually have better than original capacity. In some cases after 1,000 hot runs, cells had lost only twenty per cent of their original capacity.

Life tests of many "A4" cells are also made, but at somewhat lower temperature, as it is desired to have the conditions approach a little nearer to normal. In this case the temperature averages only 105 to 110 degrees, but every discharge is carried to zero voltage, each cell then being short-circuited some minutes to ensure its complete discharge. The severity of this test as compared to service conditions can be judged from data obtained on the "E" type of Edison cell, some batteries of which were put in commercial operation six years ago. This old type lost fifty per cent capacity in 250 runs under the conditions of this test, and yet in actual vehicle service it had a useful life of three to five years.

Two years ago the first regularly-manufactured "A"-type battery was installed in a demonstration wagon of one of the vehicle companies. After a few months of this service, during which several long test runs were made, the wagon was sold to a New York dry goods house where it is still in operation. In July just past three cells were taken at random from the battery for test, after having covered 17,000 miles. The results of the test show that these old cells, formed up under commercial service conditions, are actually better in overcharge capacity, in output on normal charge, and in efficiency than the average of cells formed up under laboratory conditions; and that the watt-hour output given on normal charge is now, after 17,000 miles, sixteen per cent above the rated watt-hour output, while the maximum output exceeds the rating by thirty-four per cent. In the light of such a performance who can set a limit to the life of the new Edison battery?

SURGING OF SYNCHRONOUS MACHINES.

DISCUSSION AT JOINT ELECTRICAL MEETING IN CHICAGO.

At a joint meeting of the Chicago Section of the American Institute of Electrical Engineers and of the Electrical Section of the Western Society of Engineers, held on November 23 at the rooms of the latter in the Monadnock Block, Ernst J. Berg, professor of electrical engineering at the University of Illinois, presented a valuable paper on the "Surging of Synchronous Machines."

Dr. Berg did not read his paper, which had been printed in advance, but gave an abstract of it and incidentally a review of the subject and a clear exposition of its principles. Beginning about 1893 the troubles for hunting engrossed the attention of engineers.

Dr. Berg's paper related particularly to the most recent cases of hunting with high-speed turbo-generators and synchronous motors. An abstract of his paper follows:

Surging, or what is often called hunting of synchronous machines, resulting in pulsations of current and voltage, is one of the most perplexing and annoying of the phenomena with which the central-station man meets. It is a subject which is of equal interest to the mechanical and the electrical engineer, since the causes and the remedies are as often mechanical as electrical.

Surging is always associated with pulsation in speed and in power. The pulsations may be caused by the lack of uniformity of the rotative speed of the prime mover, or they may be caused by the electrical operation of the machines or by both. With the limitations of speed variation of the prime movers imposed by the electrical manufacturers, there is little likelihood that the cause of the hunting is the prime mover, if the governor-mechanism and its dashpot is of good construction. It is more likely to be due to insufficient damping of the magnetic circuit of the machines or to too much damping, or in general to the electrical constants of the circuit. The theory of this phenomenon is fairly well understood, at least in so far as it applies to ideal machines.

For the sake of simplicity, the case of a synchronous motor operating from a large system will be considered. The resultant of the electromotive force impressed and of the counter electromotive force causes a cross-current to flow which lags behind the resultant electromotive force by a certain angle which depends upon the resistance and reactance of the circuit between the busbars of the large generating station and the motor, and also includes the motor reactance and resistance. The power increases with increase in this angle up to a certain point, after which it decreases and finally becomes zero. The motor is stable when, with decrease in speed—that is, with increase of this angle—the power received increases; it is unstable when this condition ceases.

There is a minimum value of reactance which corresponds to any value of resistance between the generators and the motor, which minimum value depends upon the amount of speed-variation or displacement of the armature by load or any other cause. Even if the resistance between the generators and the motor is as high as ten per cent, the required reactance for stability would be practically insignificant—far less than that which is found in any commercial machine. In other words, there can be no difficulties by such small speed-variations.

The reason for these difficulties is by far most often traced to defective design of the governing mechanism of the prime mover or to the characteristics of the synchronous machines, which do not appear in the textbooks or in ideal machines.

It is well known that in order to obtain a given electromotive force at the terminals of a generator, a certain field-excitation is required. This increases with the load, though not always with the current, which may be more or less leading or lagging; that is, magnetizing or demagnetizing.

The electromotive force at the terminals is usually smaller than the induced electromotive force. It is decreased by the impedance drop in the armature. The resultant field is caused by the magnetomotive force of the field and of the armature.

The electromotive force consumed by the armature resistance is in phase with the current and is at all moments proportional to the current. The electromotive force consumed by the self-induction or inductive reactance of the armature is ninety degrees ahead of the current.

The flux produced by the field-excitation is constant as long as the exciting current is constant. With sudden change in excitation, it changes, however, slower than the change in excitation on account of the so-called sluggishness of the field; that is, on account of the effect of the eddy currents which oppose the change. Depending upon the field construction, the time required to build up the magnetism in the field may vary from a fraction of a second in laminated structures to ten seconds or even longer in structures of solid steel, or of laminated steel with imbedded squirrel-cage windings.

The flux produced by the armature magnetomotive force would appear simultaneously with the current if the magnetic structure were perfectly laminated, and if the field-winding was open-circuited. In reality the structure is seldom so well laminated that no eddies occur and the field-winding is always excited; that is, closed upon itself through the exciter; thus, at the best, the flux appears later than the current causing it, and much later if the field poles have squirrel-cage winding.

Thus, while two machines may have the same electrical constants, the same armature resistance and reactance, the same exciation at full load and no load, the same armature reaction, their characteristics at the instant of change of load may be very different.

In the calculations of generator characteristics, the term synchronous reactance is usually introduced; it means a fictitious reactance which gives the same effect as that of the self-induction and armature reaction combined. This term is justified in

an ideal generator having uniform magnetic reluctance in all positions of the armature, and having a magnetic structure which permits the flux to change at once with the change of magnetomotive force. In a machine with squirrel-cage winding in the poles this condition is not fulfilled.

The result of this is that if, for instance, full load is suddenly thrown on the machines of the two types, in the first type the machine will take its load when the speed has dropped so that the angle between induced electromotive force and terminal electromotive force is, say, fifteen degrees, whereas in the latter type it may be only one degree. To be sure, after a short time—a few seconds—the two machines will have the same phase displacement between the induced and terminal electromotive force. The same applies to the synchronous motor, but in this case the different characteristics play an important part in the stability of operation.

For sudden variations in load the reactions in machines of greatly damped field-circuits are largely governed by the ohmic resistance and the true inductance between the generators and the motor; whereas, with ideal machines the reactions are governed by the synchronous reactance which usually is many times as great as the true reactance.

While a motor with excessively damped field-circuit can be loaded up to the same output as the ideal type, if the load increases slowly so that the armature reaction has time to exert its influence, it will break down immediately if suddenly more than about twenty per cent of full load is thrown on it. Thus, we conclude that such a motor should have some external reactance if it shall be able to carry pulsating load. While both types of motors are by theory less stable the greater the resistance, the second type is far more sensitive.

A motor of the laminated-field type, frequently used some years ago, while often operating satisfactorily, may, of course, be unstable, on account of excessive reactance.

Assume, for instance, that such a motor is operated over a line of ten per cent resistance and twenty per cent reactance. The total reactance would then be eighty-seven per cent. Such a motor is not able to carry full load and it is extremely sensitive from half load up.

Thus, too much reactance is as detrimental as too low reactance. A motor of this latter type would undoubtedly benefit by a squirrel-cage winding on the field, since such a winding reduces the armature self-induction to some extent. Such a motor would run much more stably if by some arrangement of the supply circuit its reactance could be decreased.

This explains why, with the old type of motors, it was always an advantage to reduce the self-induction in the lines connecting the motor with the generators, whereas, with modern high-speed motors and especially in the case of parallel operation of turbo-generators, it is often an advantage and at times a necessity to install extra reactances in order to obtain stability.

Every synchronous machine has a natural period, that is, a period at which it will oscillate when adjusting itself from one load to another, and this period is practically proportional to the square root of the field-excitation and inversely proportional to the square root of the moment of inertia. This period is usually between one-ninetieth and one-sixtieth of a second.

While such oscillations always take place with changes of load, they are usually of little importance since they cover a small phase-angle only. If, however, the synchronous motor is supplied power from an alternator whose speed for some reason or other pulsates at the same rate as the natural period of the motor, then a condition of resonance takes place and the machines cannot operate satisfactorily in parallel. In such case, the remedy is obviously to change the natural period, which can be done by increasing or decreasing the moment of inertia, or by changing the air-gap and thereby the excitation.

In general it can be concluded, as far as the electrical side of the surging problem is concerned, it can be solved by either one or more of the following alternatives:

1. Reduce the ohmic resistance between the machines.
2. Exclude all external reactances and put field-damping devices on machines of laminated fields and quick magnetic circuit, especially if the synchronous impedance is great; that is, if they, as generators, have poor regulation.
3. Add extra reactance in high-speed machines having good mutual induction between field and armature and sluggish magnetic circuit.
4. Change the natural period by change of air-gap or addition of flywheel, etc.

While thus something can be done by changing the electrical constants, it is but seldom that this is necessary. Ninety-five cases of every hundred can be traced back to some mechanical defect of the prime mover. Usually the governor is too sensitive, or there is some play in the various links connecting the governor proper with the steam-admitting valves. Sometimes, by the very nature of the drive, difficulties can be anticipated; for instance, when several generators or motors are belted to the same countershafting, when it is always possible that the pulleys might be of slightly different diameters or the belts of greatly different quality.

In the case of hunting between direct-connected engine-driven units, it is easily ascertained if the governing mechanism is at fault by disconnecting it and operating by throttling. Should hunting still persist, it would seem necessary to resort to some of the three electrical remedies suggested, and if these are impractical, to add some flywheel capacity.

It is believed that any surging difficulty can be solved by the remedies suggested; indeed, with practical experience of a large number of cases, Dr. Berg has never met a case which could not be disposed of by them.

The discussion was opened by Jas. Lyman, who called attention to Dr. Berg's extended work with the problem of hunting. Due to his keen power of diagnosing these diseases of synchronous machines the problem has been completely solved and nothing need be feared in this line.

P. D. Junkersfeld, D. W. Roper, W. B. Jackson and W. E. Symons narrated some interesting experiences with what seemed at the time very baffling hunting troubles. Mr. Dudley thought that governors having regulated sensitiveness would be most desirable.

In concluding the discussion Dr. Berg stated that oversensitive governors are not good because they aggravate hunting troubles. In his paper he had simplified the treatment by disregarding the effect of armature reaction on sudden load changes and taking account of armature impedance only. In reply to a question he said parallel operation of sixty-cycle gas-engine-driven generators is practicable.

AMERICAN PHYSICAL SOCIETY.

FALL MEETING IN CHICAGO.

The fall meeting of the American Physical Society was held on November 26 in the Ryerson Physical Laboratory of the University of Chicago. Morning and afternoon sessions were held, and at lunch the members were the guests of the University at the Quadrangle Club. The president of the Society, Prof. Henry Crew, presided at the morning session and in the afternoon the chair was occupied by Prof. A. P. Carman.

A number of the papers read at this meeting were of electrical interest and some of the more important of these are abstracted below. "The Hall Effect and Some Allied Effects in Alloys" was the title of a paper by Alpheus W. Smith, of Ohio State University.

HALL AND ALLIED EFFECTS IN ALLOYS.

The electrical resistance, the thermoelectric voltages, the Hall effect, the Nernst effect and the Peltier effect have been studied in the following three complete series of alloys: bismuth-antimony, antimony-cadmium, and antimony-zinc. For each of these series of alloys curves were given, showing the relation between the amount of one component and the electrical resistance, the temperature coefficient of the resistance, the thermoelectric voltage, the Nernst effect, the Hall constant, and the Peltier effect. From these curves the following conclusions may be drawn: (1) In the case of the bismuth-antimony alloys in which the components form a continuous series of mixed crystals without any compounds, it is found that none of the curves have singular points. As the concentration of the antimony in this series is increased the electrical resistance, the thermoelectric voltage, the Hall effect and the Peltier effect increase rapidly to a maximum where the alloy contains about 90 per cent bismuth and 10 per cent antimony. The temperature coefficient of the resistance, on the other hand, decreases to a minimum where the resistance has its maximum. With increasing concentration of antimony the Nernst effect decreases rapidly, so that its value in an alloy containing 80 per cent bismuth and 20 per cent antimony is of the order of magnitude of its value in pure antimony. The change of the resistance of these alloys in a magnetic field has also been studied and it has been found that the addition of the antimony to the bismuth causes this change of resistance to decrease more rapidly than was to be expected from the additive law, so that an alloy containing 30 per cent bismuth and 70 per cent antimony does not show a greater change of resistance in a magnetic field than is shown by pure antimony. (2) In the antimony-cadmium series of alloys in which the compound SbCd is formed when the metals are present in the ratio of their atomic weights, and in the antimony-zinc series in which the compound SbZn is formed when the metals are present in the ratio of their atomic weights, each of the curves has a well defined singular point corresponding to the compound. In either of these series of alloys the addition of cadmium to antimony or the addition of zinc to antimony causes the resistance, the thermoelectric voltage, the Hall effect and the Peltier effect to increase to

values which are very much larger in the compound than the corresponding values in pure antimony. A further increase in the antimony or the zinc in the alloy causes each of these quantities to sink suddenly to a value which is of the order of magnitude of its value in antimony. On the other hand, the addition of cadmium or of zinc to antimony causes the temperature coefficient of resistance to decrease rapidly at first, then more slowly until the compound is reached, when the temperature coefficient jumps to a value which is of the order of magnitude of its value in pure metals.

This was followed by a paper by Robert F. Earhart, also of Ohio State University, on "The Discharge of Electricity Through Gases at Various Temperatures."

ELECTRIC DISCHARGE IN GASES.

A form of apparatus was constructed which permitted the measurement of the potential difference required to cause a discharge in a known volume of gas. The discharge took place between plane parallel electrodes whose edges were insulated. The discharge chamber was contained in a furnace electrically heated, temperatures being measured with a thermo-couple. The volume of gas contained in the discharge chamber being known, measurements of pressure and temperature enabled the mass of gas functioning in the discharge to be determined. In order that moderate potentials secured from a storage battery might be utilized, low gas pressures were used. The method of procedure was, at each fixed temperature, to measure the potentials required to produce discharge at a number of pressures. The temperature range extended from 20 to 600 degrees centigrade. The results for air, hydrogen and carbon dioxide show that Paschen's law may be extended to variations caused by temperature within the range covered; that is, the potential producing discharge is a function of the mass of gas separating the electrodes.

The general conclusions are: (1) Potentials required to produce luminous discharge from 20 to 600 degrees depend merely on the mass of gas between the electrodes. (2) Potentials required to maintain the discharge in air do not fall below 345 volts until temperatures approaching 1,000 degrees centigrade are reached. (3) The minimum energy required to ionize a gas by collision depends to a very slight extent upon the temperature of the gas for temperatures less than 1,000 degrees.

A paper by F. C. Brown, of the University of Iowa, was entitled "The Electrical Properties of Light-Positive and Light-Negative Selenium," and will be abstracted in a later issue.

"A New Formula for the Vapor Tension of Water" was the title of a paper by K. E. Guthe and A. G. Worthing, of the University of Michigan. In this it was shown that between zero and 200 degrees centigrade, the formula

$$log\ P = 7.39992 - \frac{8893}{T^{1.2808}}$$

gives the relation between temperature and pressure more correctly than any heretofore proposed. In this formula, P is the pressure in millimeters of mercury and T is the absolute temperature in centigrade degrees. The greatest discrepancy between experimental values and those given by the formula is 0.06 degrees.

E. H. Williams, of the University of

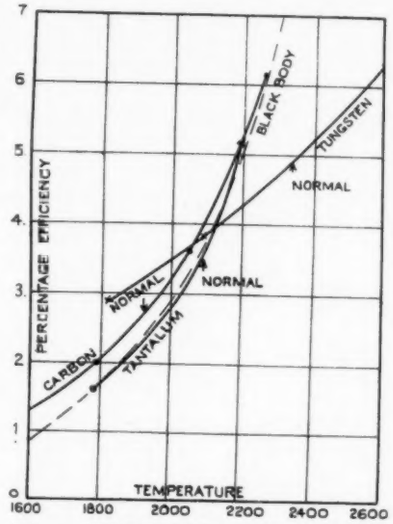


FIG. 1.—TEMPERATURE AND RADIANT EFFICIENCY.

Illinois, read a paper entitled "A Comparison of the Influence of Planes of Transverse Section on the Magnetic Properties of Iron and of Nickel Bars."

MAGNETIC PROPERTIES OF IRON AND NICKEL.

The results of Maurain have indicated that, for very thin layers, the magnetic properties of iron and of nickel are different.

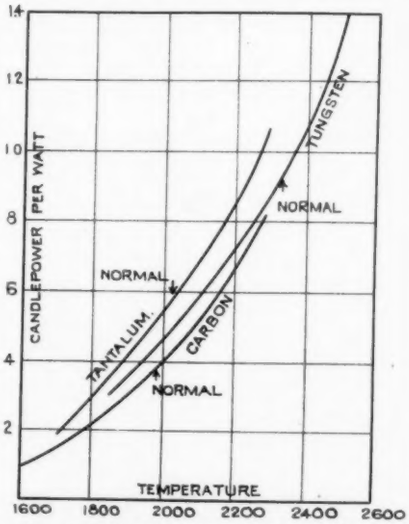


FIG. 2.—TEMPERATURE AND LUMINOUS EFFICIENCY.

Ewing and Low have shown that the influence of a transverse plane of discontinuity on the magnetic induction of an iron bar is to produce a large magnetic resistance. Now, if the surface layers of nickel have different magnetic properties from those of iron, it would appear that the effect of transverse joints would be different in the two metals. In this investigation, the effects of surface layers in bar magnets of iron and of nickel, produced by cutting the bar in planes of transverse section, have been studied and compared under various conditions of field strength and longitudinal pressure. The final results are in agreement with what one should expect from the observations of Maurain on the magnetic properties of very thin layers of iron and of nickel. Whereas the effect of transverse joints in iron is always to produce a decrease in the magnetic induction whatever the value of the field strength or of the mechanical pressure, in the case of nickel the results are very different. In this metal, with magnetic fields greater than 25 gausses, the effect of transverse joints is to increase the magnetic induction. Data and curves showing the effect of transverse joints under various conditions of pressure and field strength were given. The change from a decreased to an increased flux takes place at lower fields with higher mechanical pressures.

At the afternoon session C. Nusbaum presented a paper on "Valve Action of Aluminum, Magnesium and Their Alloys." His experiments indicated different critical voltages under different conditions. An alloy with small percentages of magnesium gave a large rectifying effect, which decreased at first rapidly with increasing magnesium, then more slowly and then rapidly again, becoming zero at about fifty per cent.

"The Luminous Efficiency of Incandescent-Lamp Filaments" was presented by W. E. Forsythe, of the University of Wisconsin.

EFFICIENCY OF INCANDESCENT LAMPS.

In this work, undertaken to show the variation of the efficiency of the different filaments as a function of the true temperature, the efficiency was defined as the ratio of the energy in the visible part of the spectrum to the total energy. Also the efficiency in candlepower per watt was measured as a function of the temperature. To measure the energy in the visible spectrum, while it was giving as much light as the total radiation, light was brought out along two paths, from the same source, the one being dispersed and a screen so set as to cut off the infra-red radiation at the *A* line, and then the remainder recombined and balanced photometrically against the total radiation. To bring this back in line with the total radiation required a bent-arm spectroscope. The temperatures were measured with a Holborn-Kurlbaum optical pyrometer. This gave black-body temperatures which were corrected to true temperatures by a method given in another paper by Professor Mendenhall. The running temperatures of the different lamps were measured by the method due to Waidner and Burgess, which consists in putting the lamp studied in place of the comparison lamp of an optical pyrometer and balancing against a source with known temperature. The energy in the visible and the total spectrum was measured by a Ruben's thermopile connected to a Broca galvanometer and so adjusted as to have a sensibility of about 300 candle-meters. To make the deflections of the galvanometer about the same in each case a revolving sectored disk was used in the path of the total radiation. Carbon, tantalum and tungsten filaments have been used. The results for both methods are shown in the curves. High accuracy is not claimed for the second set of curves, due to the difference in color of the lamps compared, especially at the higher temperatures, as the candlepowers were measured with a Lummer-Brodhun photometer.

The Conservation of Coal.

In his inaugural address before the Institution of Electrical Engineers on November 10, at the new home of the Institution on the Victoria Embankment, London, S. Z. de Ferranti, the president, took as his subject "Coal Conservation, Home Grown Food and the Better Utilization of Labor." An abstract of the address follows:

There are few subjects more important to the people of this country than the question of the rapid and ever-growing rate at which we are using up our coal supplies. Many writers have dealt with this subject, and have suggested various remedies.

Taking all the uses for coal into consideration, I believe that we are getting back an amount represented by useful work of one kind or another of much less than ten per cent of the energy in the coal. We can never, of course, hope to get anything like the full value of the energy in the coal, but, on the other hand, throwing away more than ninety per cent of the value of our coal in the process of conversion is of the greatest possible concern to the country. Moreover, there is a further waste involved in our present methods of using coal which is only second in importance to the above.

We now dissipate nearly the whole of the valuable by-products contained in the coal, consisting principally of fixed nitrogen.

A third subject to be mentioned is that of our wasted labor. We should aim at the supply of all our reasonable wants with the least possible amount of labor.

Looking at the question more in detail, we can first consider the labor spent in and about raising and distributing the coal which we now use, and which we would save under more economical conditions. Then there is the vast army of workers who are employed in cleaning up the dirt that is produced by our present methods of using coal. If you consider what goes on in every household you will see how large a proportion of the domestic labor is devoted to this. There are also all the people who are now employed in the process of burning coal for all the various uses to which it is put and who represent an enormous amount of labor, which, under a more efficient system, could be turned to better account in the interests of the country.

This efficient working of the country to a large extent depends upon the proper use of its natural resources in the form of material and labor, and the saving of all waste in both of these which can possibly be brought about.

Considering the question of coal saving, by-product recovery, and labor saving, it is evident that the only way of obtaining material improvement under these heads is to concentrate the process of transformation of the coal and to carry out this process at the smallest reasonable number of centers.

It is in the process of transformation of coal into work in the form of heat and power that the great loss occurs, as this is always a most difficult process and requires the highest scientific and practical skill to carry out with even very moderate economy.

It has been proposed, with a view to accomplishing the above ends, to treat the coal at central stations and turn it into gas and distribute the energy in this form, but this process only goes a small way towards a solution of the problem, as under it combustion—which is such a difficult problem—would be taking place at numerous points over the whole country, all tending to inefficiency, and the conversion of the gas into power is by no means easy, involving running machinery of the reciprocating class, requiring special and skilled attendance.

It appears that with a problem such as we are discussing, it is fundamental that the energy in the coal should be converted at as few centers as possible into a form in which it is most generally applicable to all purposes without exception, and in which it is most easily applied to all our wants, and is, at the same time, in a form in which it is most difficult to waste or use improperly.

We are therefore forced to the conclusion that the only complete and final solution of the question is to be obtained by the conversion of the whole of the coal which we use for heat and power into electricity, and the recovery of its by-products at a comparatively small number of great electricity-producing stations. All our wants in the way of light, power, heat and chemical action would then be met by a supply of electricity distributed all over the country.

It must, however, be remembered that the distribution of energy in the form of electricity instead of coal can only be effectively carried out when it can be done in such a way that it is available for all the purposes for which coal is now used, and this can only be the case when the conversion is effected at such an efficiency as will cause the electric energy delivered to represent a high percentage of the energy in the coal. Failing this no scheme for conversion at the pit's mouth and delivery of energy in the form of electricity is sound. There is also another controlling factor which must be satisfied in order to make this scheme possible. Both the conversion of the coal into electricity and the distribution of the current must be effected at a low capital cost so as not to overburden the undertaking with capital charges.

Considering the various processes of conversion which are now available, or which may be invented, and their possible and probable efficiency, we first come to electric generators driven by reciprocating steam engines. Their economy, expressed in the form of energy in the coal to electric energy, may be taken as a maximum of ten to twelve per cent. This is far too low an efficiency to make any scheme such as I have already indicated possible, besides which the capital expenditure and the complication involved are far too great and the size of the units too small to be thought of for the purpose in view.

We next come to large steam turbines such as have been constructed up to the present, and see that their maximum efficiency may be put down at about seventeen to eighteen per cent.

Next in the list, in order of economy, comes the big gas engine fed from gas producers, with an efficiency of coal energy to electric energy of possibly twenty-five per cent.

In the future we have to look towards two other means of conversion—the gas-turbine-driven electric generator and the production of electricity in some more direct way from the coal, but these two means of conversion, although being capable of giving the most efficient results, are so much in the distance, that they are quite beyond our present consideration.

After very careful thought on the subject I have come to the conclusion that, in order to supply electricity for all purposes it would be necessary to have a conversion efficiency of not less than twenty-five per cent.

In the conversion of coal into electricity one of the most important considerations is the load-factor. Electricity used for lighting, cooking, power, and traction must be supplied as and when required. On the other hand, domestic heating will be done largely through the medium of heat storage, and is therefore a controllable form of demand. Metallurgical and chemical processes, which depend for their success upon a very cheap supply of current, will have to be so adapted and modified that they can take current intermittently and so fill up the load curve, thus enabling the current which they require to be produced with the least capital expenditure and at the same time greatly assisting the good conversion efficiency of the whole supply. I believe that under the circumstances a load factor for 60 per cent would be obtained.

Considering now the means to be adopted for converting the coal into electricity, and the efficiency at which this can be done, we find that in gas-engine-driven alternators we have a system theoretically capable of returning 25 per cent of the energy in the coal in the form of electricity, and from this point of view they would meet our requirements.

The gas engine, however, as a converter of energy on the scale required suffers from the fact that the units are too small and the cost of the complete installation is too high. These difficulties appear to defer the realization of an all-electric scheme until electricity is generated by some gas turbine of the future, or direct from coal by chemical action.

There is, however, an intermediate process of conversion which will give the necessary efficiency without undue complication or expense. The steam-gas turbine in which steam is used in the state of a gas at a high temperature throughout the process of conversion into work, gives theoretically a high efficiency at workable temperatures, and will, in course of time, supply the necessary means of conversion for effectively turning our coal into electricity.

The positions of the actual generating stations would be largely controlled by the facilities for obtaining coal and water for condensing. In many cases they would be close to the colliery districts, and the current would be transmitted to the points of demand.

In other cases, where a considerable demand was concentrated at a distance from the sources of coal supply, and where the coal could be cheaply carried—especially by water—stations would be installed and would supply electricity to meet the surrounding demand.

Many works taking a large quantity of electricity for metallurgical and chemical purposes at a very low price would be built adjoining the generating stations, and other existing works would be at such short distances that the capital costs for distribution of the electricity which they used would be very small. Estimating on the basis of the typical generating station considered the capital cost of generating works would be $34 per kilowatt. The cost involved in the distribution system on such a scale is difficult to estimate. Sixty-three dollars per kilowatt would be amply sufficient. In 1903 in England 150 million tons of coal were used, exclusive of gas plants. Sixty million tons would be sufficient, if properly used. Two and one-half billion dollars would be the capital required to convert this into electric power and transmit it to the point of consumption. This is more than the total capital now invested in electrical undertakings and eight or nine times that invested in the central-station business.

The cost of producing the electricity required under the scheme may now be considered. Capital costs taken at 8½ per cent upon the money invested, form by far the most serious item, and amount to 0.155 cent per unit. The works cost would not exceed 0.072 cent, bringing up the total costs, including interest and all other charges, to 0.229 cent per unit.

In arriving at the above figures for the costs of generation, sixty million tons has been taken as the annual coal consumption, and this has been charged at an average price of $2.50 per ton. On the other hand, it has been assumed that with improved processes of conversion, one ton of coal will yield fixed nitrogen equivalent to 100 pounds of sulphate of ammonia. The pres-

ent price of this commodity is over $60 a ton, but considering the large scale of production and the necessity of supplying it at a low price to make its use general for agricultural purposes, $40 per ton is allowed. This reduces the cost of the coal to fifty cents per ton, which largely accounts for the low works costs.

The cost of chemicals required to make the fixed nitrogen available together with the necessary labor involved in the process, would be met by the sale of the other coal by-products—principally consisting of tar and oils.

It is, of course, well known that firing by means of gas compares unfavorably with using the coal direct. It is also generally found that a good return of fixed nitrogen in the form of ammonia is only obtained from the coal at a sacrifice of thermal efficiency, and also involves a much smaller yield of the other by-products which can be extracted from the coal, but now that the importance of these matters is realized a great deal of work is being done to improve the processes, and eventually it will undoubtedly be possible to obtain the high return spoken of.

The average price at which current would be supplied throughout the country may be taken as 0.25 cent per kilowatt-hour. The charges would not be uniform, but would be graded according to the position and nature of the load supplied.

It is interesting to consider the effect of such a supply of electricity upon its present and future uses. Taking lighting to begin with, it will be clear that when it is obtained from current at the much lower prices that would rule under the all-electric scheme, no other form of light would have a chance in competing with it.

When electric heating and cooking are carried on with current at the very low figures at which it would be possible to sell for these purposes, it would only be a matter of time for all heating and cooking to be done by means of electricity.

Regarding the supply of power, electricity is now admittedly the most convenient form of power for all purposes, and this, again, notwithstanding the costs involved on the comparatively small scale on which we now produce. The overwhelming advantages of electric power at a price at which it would be supplied on the all-electric scheme would clearly insure its use for all power purposes.

The case with regard to electric railways is well known, and any reduction in the costs of running due to cheaper current would, of course, act greatly in favor of these undertakings, and would help to extend their usefulness. The electrification of main-line railways has not yet progressed very far, as it is hard to make out a sufficiently strong case to warrant the large expenditure necessary for electrification; but there is little doubt that growing traffic, which necessitates additional works, will be best met by electrification, which will enable a greater return to be obtained from existing lines and works. The electrification of our railways would be greatly assisted and made a more profitable investment if a supply of current at such a figure as we are now considering were available for their working.

The manufacture of pig iron is quite the most economical use of coal that we now have, but recent work with electric smelting furnaces has shown that it is only necessary to have electric current at a low enough price and for sufficient experience to be obtained to make it more economical to smelt iron electrically than by present methods, and using only sufficient coke to provide the carbon for the purpose of reduction. It may be taken that when worked on a sufficient scale a quarter of a ton of coke would be required per ton of iron produced, and that four tons of iron would be obtained per kilowatt-year. This would mean that about 0.42 tons of coal would have to be converted into coke and used per ton of iron, together with about 2,200 kilowatt-hours, which, at 0.17 cent, would come to $3.80 per ton of iron. As the electric furnaces would no doubt closely adjoin the generating station the price named for current would be a very good one. We should thus have a cost for coke and electricity of about $4.75 per ton of iron produced.

Pig iron now requires about two tons of coal per ton of iron produced, giving $5.00 as the cost of fuel per ton of iron produced. It is probable that the production of pig iron electrically would involve less plant and a less upkeep of plant that at present; also a good deal less labor would be required. Improvements in the process brought about as the result of experience would, no doubt, further reduce the costs, and would result, in all probability, in a better article at a lower price. Steel-making electrically is already in extensive use, and even with present facilities for generating the current which the process requires, is beginning to make considerable headway. All steel would, of course, be produced electrically as soon as sufficient experience had been gained regarding details and a supply of very cheap current was available. Foundry work in both iron and steel would be most conveniently carried out by means of electric melting. It is already known that the electric furnace gives the best results obtainable for steel castings. The heating of steel for rolling, forging, and annealing will be most efficiently carried out electrically as soon as the cheap supply warrants experimenting in this direction. In fact, all furnace work for which coal or gas is now used could be more satisfactorily done electrically when an abundant and cheap supply is available.

We now use aluminum for a number of purposes, notwithstanding our want of knowledge as to the best ways of working it. When our experience with aluminum in any way approaches what we now know about the working of steel, it is certain that vast quantities of this material will be used throughout the world. The manufacture of aluminum is another of the processes which will be greatly facilitated by a cheap supply of electricity. In fact, it may be said that aluminum can only be produced economically at present in water-power countries, but as an intermittent supply of electricity could be given under the proposed scheme at a lower price than it is being obtained from water powers, we should be in a better position than the water-power countries to manufacture this metal. With cheap electricity available, electrochemical processes must grow and multiply to an enormous extent.

Summarizing the whole position, it may safely be said that, wherever coal, gas or power are now used, everything for which they are used will be better done when electricity is the medium of application.

Hardly less in importance in the all-electric scheme is the question of the by-products which become available by the proper use of our coal. These consist principally of fixed nitrogen, together with tar and oils. Fixed nitrogen in the forms of sulphate of ammonia, nitrate of soda, and nitrate of lime are most valuable fertilizers, and enable land continually to produce the same crops with a greatly increased yield per acre. It is now beginning to be understood that intensive farming of the land also involves intensive cattle raising, and that it is very advantageous greatly to reduce the amount of grass land and instead to grow crops intensively cultivated, as in this way a given amount of land can be made to produce a much larger yield.

If it was found that a larger amount of fertilizer than the three million tons of sulphate of ammonia, which would be the principal by-product from the sixty million tons of coal turned into electricity, could be advantageously used, this would be very economically produced from the electrical station by the oxidation of atmospheric nitrogen, giving a valuable fertilizer in the form of nitrate of lime. This could be made intermittently by means of current, filling up the load curve and would not necessitate the expenditure of any more money on plant for generation or transmission of the current. It would, however, require the burning of additional coal, and this in itself would add to the sulphate of ammonia available.

The output of the twenty-five million kilowatts of plant installed has been reckoned upon a sixty-per-cent load-factor, but it is quite possible that the load curve could be still further filled up by an additional twenty per cent for any purposes such as those just stated. In this way it would be possible to burn an additional twenty million tons of coal annually, producing a million tons of sulphate of ammonia and other by-products, and 43,800 million additional units, which could be sold at a considerable profit at 0.10 cent per unit, as the cost would not exceed 0.02 cent per unit.

Considering the general effect of the all-electric scheme, in which, with but small exception, the whole of the coal used is turned into electricity, the first important effect would be the saving of some eighty to ninety million tons of coal a year. As we should produce the whole of our food requirements, we should not have to export our capital in the form of coal to help pay our food bill. In this way, by making these two savings, we could prolong the useful life of our coal measures two and a half times, and still have twenty million tons of coal a year available for the use of our steamships over and above the coal required in the country.

The saving of labor now employed in raising the vast amount of coal which we now waste or send abroad, the labor employed in transporting the coal and using it for all the various purposes for which it is now required, together with the labor employed in cleaning up and getting rid of the effects of burning coal according to our present methods, would all be available for additional manufacturing of the articles now imported and for use on the land.

Cheap electricity would greatly stimulate all manufacturing operations, which would, in turn, enable labor to be better paid.

The saving of so much wasted labor and material would greatly add to the prosperity of the country and so enable us to support a larger population living under more healthy and comfortable conditions.

Of course there are many things which at present stand in the way of realizing such a scheme as outlined. There are many technical details which nothing but an immense amount of work can solve satisfactorily. There are also political and legislative difficulties standing in the way, but these, when the time arrived, would have to be got rid of rather than allow them to handicap the advance of the country. It is only a matter of time before such a scheme is carried out in its entirety.

What interests us most, perhaps, is the question of how long it is likely to be before the all-electric idea becomes possible. At present there is so much required to be done to make it workable in all its details that it seems as though its realization would be long deferred. It must, however, be remembered that knowledge is continually being acquired which brings us nearer to its realization, and that things engineering, and especially in electrical engineering, now move very rapidly. It may therefore come to pass that the all-electric idea, with its far-reaching changes and great benefits, will become an accomplished fact in the near future.

SOME TYPES OF CIRCUITS FOR VOLTAGE, CURRENT AND POWER CONTROL.—III.

TRANSFER-COILS AND SWITCH-CONTACT WEAR.

BY CLARENCE I. ZIMMERMAN.

A transfer-coil, as the term is used here, is an inductive coil employed to transfer the load from one transformer tap to another. It is normally left in the circuit and it distributes the main current, by reason of its reactive properties, between the two transformer taps across which it is connected. The transfer-coil circuit, as it is ordinarily in use, is shown in Fig. 10. Figs. 11 and 12 will be described with particular reference to the pressures affecting the burning of the switch contacts when the coil is transferring the current from one set of taps to another.

Description of Fig. 11.—In this circuit the transfer-coil is being used to lower the load on the secondary by transferring the end n of the coil from A to C. Switch B is closed and switch A has just been opened. The arrows with the double-heads represent the main current flow, and the arrows with single-heads and tail marks represent pressures.

e_1 is the highest pressure in use on the secondary side.

e_2 is the pressure between the active taps q and p, or between p and o. The former set was just in use.

e_3 is the difference between e_1 and e_2.

Before opening switch A, the pressure e_4 across the load L was $e_3+e_2/2$.

e_5, after switch A is open, is a reactive pressure whose value is proportional to the magnetic saturation value of the iron core, to the number of turns on one-half of the transfer-coil n-m, and to the value of the main current I. With ordinary designs e_5 would be greater than e_2. Let this pressure then be represented by $k\ e_2$, k being a figure greater than unity.

e_4, after switch A is opened, is a reactive pressure approximately equal to e_5 as long as the core is not saturated with magnetism, but it is less than e_5 after the core becomes saturated. Assuming the magnetization when switches A and B are closed, to be one-half of the magnetization after switch A is opened, it follows that the electromotive force induced, or e_4, must be twice what it was before. Hence e_4 equals e_2 (approximately).

The voltage across the whole transfer-coil n-m is e_4+e_2, or, under the assumed conditions, ke_2+e_2. The voltage across switch A is $e_4+e_2+e_2=ke_2+e_2+e_2=ke_2+2e_2$. This condition exists when switch A is wide open.

At the moment of opening switch A, we attempt to instantaneously reverse the polarity of the inductance coil. In this case the self-induced electromotive force of demagnetization acts in the direction n-m, or in oppositon to the pressure tending to make the main current I flow. The more quickly we attempt to demagnetize the core, the greater is this opposing pressure. It has no path in which to discharge except in opposition to the direction that the main current tends to flow through switch B and one-half of the coil n-m. The result is that the potential of n is forced much below m, p and q, and switch A gets the concentrated effect. If the load L be inductive, the potential will be intensified. There is in addition, a moment later, a counter electromotive force of self-induction during the period that the main current is rising up to its full value in the coil. This counter-pressure tends to hold back the main current.

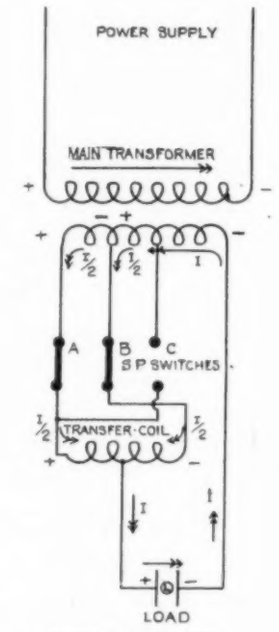


FIG 10-TRANSFER-COIL

The rate of opening switch A will materially affect the intensity of the pressure across its contacts. When it is opened very quickly the worst static effects are produced. If it is opened very slowly, the contacts will be burned by arcing. There is a rate of opening the switch which will produce the minimum amount of trouble.

Description of Fig. 12.—In this circuit the transfer-coil is being used to increase the load on the secondary by transferring the end n of the transfer-coil from C to A. Switch B is closed and switch C has just been opened. Assuming switch C to be wide open, e_1, e_2, e_3, e_4 and e_5 follow practically the same description which was given for the similar potentials in Fig. 11.

The voltage across switch C, or e_7, is not the same as that across switch A, for it is now the difference between the voltage across the transfer-coil (e_4+e_5) and e_2, instead of their sum, as an inspection of the figure will show. This voltage is then $ke_2+e_2-e_2=ke_2$, which is the reactive voltage of one-half of the coil m-n when the main current I is flowing.

At the moment switch C is opened, there is a comparatively small counter electromotive force of self-induction due to the increasing current in one-half of the coil. The polarity of the coil is *not* reversed and there is thus no magnetic energy to be dissipated. On the contrary the magnetism of the coil is increased which means absorption of energy. Switch C is thus not subjected to the severe pressures that switch A was.

Summarizing the above discussion of Figs. 11 and 12, we note: When the load is being *decreased*, the switch which opens one end of the transfer-coil breaks one-half of the main current against the momentarily self-induced pressure of demagnetization of the transfer-coil, and attempts to stop the main current in the circuit. This pressure due to demagnetization is followed by the counter pressure of self-induction due to the rapid rise of the main current in the coil. The final pressure across the switch gap, is, roughly, more than three times the pressure across the transformer taps which were just in use.

When the load is being *increased*, the switch which opens one end of the transfer-coil breaks one-half the main current at a comparatively small momentary pressure of self-induction which is caused by the sudden increase of current and magnetism in the coil. The final pressure across the switch gap is, roughly, greater than the voltage across the transformer taps which were just in use, but it is less than the switch-gap pressure when the load is being *decreased*, by twice the voltage between the transformer taps.

When the transfer-coil is on the primary instead of on the secondary side of the transformer, the conclusions just reached are the same, insofar as the increasing and the decreasing of the load are concerned, but just as it was shown in the discussion of transfer-resistances, the increasing and the decreasing of the number of turns gives different potential rises and burning effects at the switch contacts.

As with the transfer-resistances, an electrical condenser or a safety-valve of the aluminum electrolytic type might be used to reduce the high-potential stresses. Another method for special cases would be to temporarily insert across a portion or the whole of the transfer-coil, a non-inductive resistance or a condenser which will absorb the magnetic energy of the transfer-coil when the attempt is made to instantaneously reverse its polarity. This is shown in Figs. 13 and 14. This resistance or condenser may be removed when the discharge has been absorbed.

In Figs. 13 and 14, both of the switches G and G^1 are to be closed just before the load is to be *decreased* by means of A or C, and may be opened again after A or C has been opened.

In Fig. 14 is shown an electrical condenser which absorbs the magnetic discharge energy of the transfer-coil when the load is being decreased. This condenser may be of the aluminum electrolytic safety-valve type. The electrical condenser or its substitute may be placed across only a part of the transfer-coil.

Fortunately, in some applications, such as starting induction motors or in speeding up single-phase railway motors, the transfer-coils are not called upon to lower the load. When the load is to be decreased to some definite value, the power may be cut off entirely and then increased from zero to the desired value by going through the increasing operations without serious burning of switch contacts. Whenever transfer-coils are to be used for both raising and lowering heavy loads some auxiliary device should be used to reduce the troubles at the switch contacts.

DIAGRAMS.

Fig. 10. *Transfer-Coil.*—This figure shows the division of current between the transformer taps caused by the reactive properties of the coil.

Fig. 11. *Transfer-coil in Use.*—Lowering the secondary pressure by opening A and, later, closing C.

Fig. 12. *Transfer-coil in Use.*—Raising the secondary pressure by opening C and, later, closing A.

Fig. 13. *Transfer-coil Circuit.*—A resistance is here shown to reduce the wear of switch contacts when decreasing the load.

Fig. 14. *Transfer-coil Circuit.*—A capacity is here shown for reducing the wear of switch contacts when the load is being decreased. The capacity may be an ordinary condenser or an aluminum electrolytic condenser-safety-valve.

[This article will be followed in early issues by two others dealing with modern types of potential regulators of the induction type.—ED.]

The Institute Edison Medal.

The Edison Medal Association, which was formed by the friends and admirers of Thomas A. Edison to found a gold medal in the American Institute of Electrical Engineers, celebrating the invention of the incandescent lamp and twenty-five years of its successful use, has just closed up its accounts. The Association began its work five years ago and raised a fund of over $7,600 for the purpose. Of this account, $5,000 was placed in the hands of the Institute for the Medal Award Fund. The contract for the design of the medal was made with James Earle Frazer, the well known sculptor, who, owing to the change in the deed of the gift, was called upon to make two separate designs. The medal was at first to be awarded to students of electrical engineering, but this was changed and only one award was made to a student competing, the amount being $150 without a medal, but with a special certificate. Under the new deed of gift, the medal is awarded for meritorious achievement in electricity and this year Elihu Thomson became the first recipient. The $5,000 fund, since it was placed in the hands of the Institute, has grown considerably. The officers of the Edison Medal Association engaged in carrying out this work on behalf of the subscribers, and presenting them with the Institute and with the Institute Edison Medal Committee have been: Samuel Insull, president; Frank S. Hastings, treasurer; T. C. Martin, secretary.

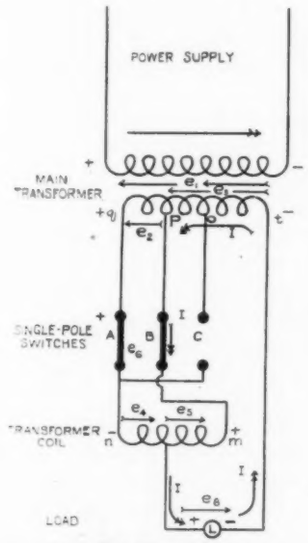


FIG 11 - TRANSFER-COIL IN USE

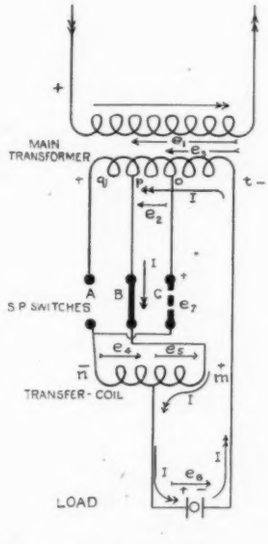


FIG 12 - TRANSFER-COIL IN USE

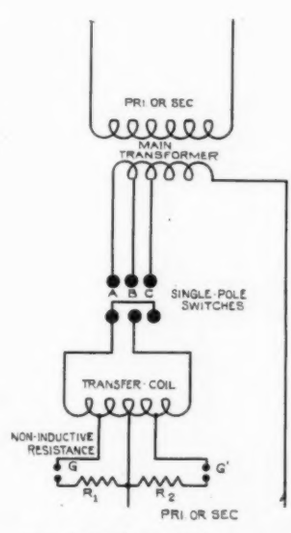


FIG 13 - DEVICE TO REDUCE WEAR OF CONTACTS

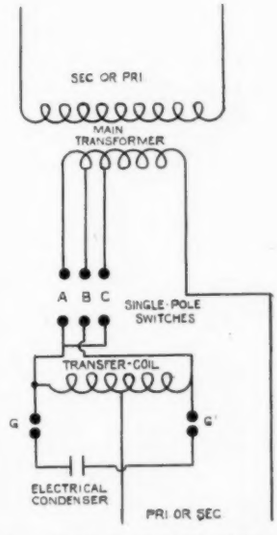
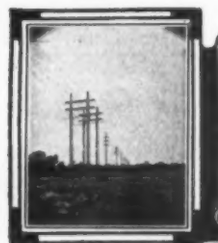


FIG 14 - CONDENSER TO REDUCE WEAR OF CONTACTS



CENTRAL-STATION PRACTICE

Transmission—Interior Wiring

ELEMENTS OF POWER-STATION DESIGN.—XIV.

UNDERGROUND TRANSMISSION.

BY W. B. GUMP.

The advent of high potential on overhead lines has increased the territory for power distribution from central stations, and has extended the limits of power transmission far beyond the point formerly regarded as ultimate. As the art advances, we may justly expect further extensions, finally permitting the economical transmission of power over distances many times greater than present conditions allow.

The extended territory, made possible by improvements in the transmission line, has demanded improvements also in the underground system in order to utilize the power to the fullest extent at the point of delivery. In other words, the requirements of electric power distribution in the thickly populated districts has demanded a means of economically transmitting electric power underground. The electric cable, being the only available means of accomplishing this end, has necessitated careful study and investigation. Due chiefly to the high cost of insulating electric cables it has not been feasible to install systems capable of carrying a potential above 30,000 volts. The greater number of high-tension cables transmit power at less than 15,000 volts. For this reason the cost of a cable system in a large and densely populated district is enormous, and in not a few cases represents an investment far in excess of the cost of the generating plant.

Of the materials employed for insulation, *viz.*, paper, rubber, and varnished cambric, the first is the most widely used on account of its lower cost and long life. For wiring inside of stations a considerable amount of cambric cable is being used, and it is highly satisfactory when properly installed.

Duct Systems.—The materials generally used for conduit construction are: (*a*) Iron pipe; (*b*) creosoted wood; (*c*) bituminized fiber; (*d*) clay tile.

The first two may be eliminated, as far as high-tension practice is concerned. This leaves but two systems to be considered, the bituminized fiber and clay tile. The latter material is in general use for outside construction, while for power-station work fiber conduit is very popular.

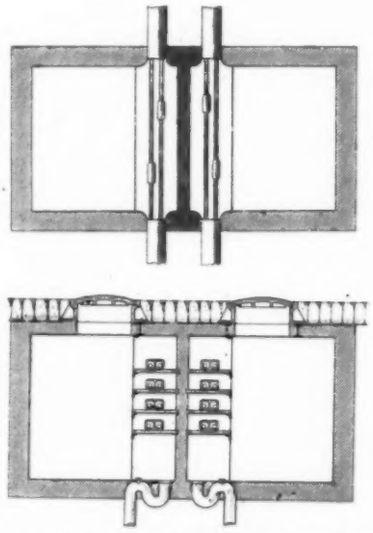


FIG. 1.—MANHOLE BUILT OF REINFORCED CONCRETE.

There are five important properties pertaining to fiber which are factors promoting its use: (*a*) Light weight; (*b*) high insulation; (*c*) proof against moisture; (*d*) uniform in structure; (*e*) easy to aline.

As high insulation and freedom from moisture are not essential qualities to duct construction, as far as lead-covered cables are concerned, tile conduit is highly satisfactory, and its comparatively low cost has made its use very extensive. It has considerable weight, and where shipments must be made over long distances, the question of freight may become so serious as to favor the adoption of fiber conduit. In either system the material is laid in concrete, after being properly alined, and when set forms a solid and substantial construction.

Station Wiring.—For potentials not exceeding 13,000 volts, tile duct is as satisfactory for cable runs within the station as bituminized fiber. It may be said, however, that tile is less flexible in conforming to certain locations, and for this reason it will generally be found that the fiber satisfies the conditions more readily.

During the period when concrete is applied the conduit is likely to fill with water where there are bends forming pockets. Moisture is certain to accumulate, and after the concrete has fully set, the remedy is to pump out the conduit and allow a blast of air to circulate through each duct. This air may be conveyed from a compressor, which is ordinarily installed for other purposes. When not too inconvenient it is advisable to heat the air, so as to hasten the evaporation and dry out the fiber. The process mentioned will be found to eliminate entirely any dampness in the conduits, and will restore their original insulating properties. Wooden plugs can be placed in the ends of conduit to prevent water, concrete, and other material from entering. As to moisture, however, every precaution should be taken before the wiring is installed, and it should not be concluded that the conduit is dry even though the ends were closed.

Heat Radiation from Electric Cables.—The fact was pointed out in a previous chapter that inclosed conductors are subject to greater restrictions regarding heat radiation than open conductors. It is often practicable in power stations in which there are large groups of inclosed cables to install a special ventilating equipment to take care of excessive heat.

In the case of long runs under the

streets, the number of cables in one group must be limited, since serious trouble in one cable may easily be communicated to the others. Hence a very large portion of the plant output may be cut off. The volume of heat radiating from a group of cables may easily reach the danger point if not properly provided for, and in designing a duct system this fact must be kept in mind.

In transmitting power to substations it is feasible to separate the cables into two divisions, spacing the ducts with sufficient distance between the two groups to remove any possibility of contact between them. With this arrangement the groups may be entirely isolated from each other, forming practically a duplicate system. In this manner the liability of having interruptions is greatly diminished.

For high-tension underground service, three-phase three-conductor cable is most common. This is almost invariably paper-insulated and is always lead-covered. For single-phase transmission a limited amount of concentric cable has been employed. There are several serious objections to this form of cable, among them being the fact that the heat radiation is not equally divided between conductors. The result of unequal radiation is unequal resistance,

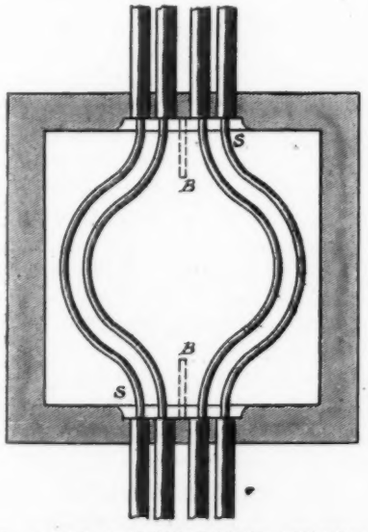


FIG. 3.—AN OBJECTIONABLE INSTALLATION.

hence an unequal loss between conductors. With a two-conductor concentric cable the inner conductor should be made larger than the outer, the difference in size depending upon the current value, which will equalize the average loss between conductors. With the current at maximum the loss will be greatest on the inner conductor, due, of course, to slower dissipation of heat. At minimum load the reverse condition takes place, when the outer conductor

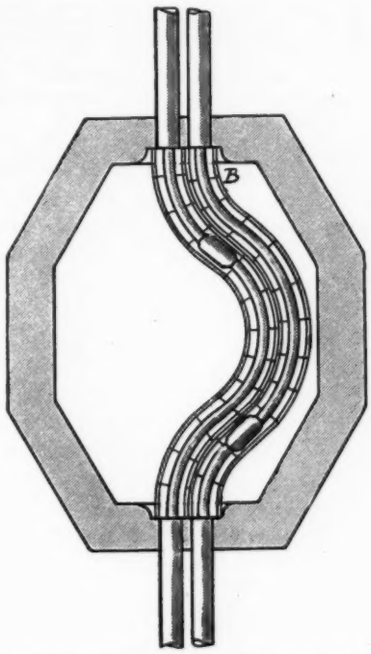


FIG. 2.—CONTINUOUS DUCT SYSTEM.

carries a greater current per unit of cross section than the inner conductor, and is therefore subject to a loss exceeding that of the inner conductor.

Design and Construction of Manholes.—The first thing to be determined in laying out an underground system is the number and location of manholes. When the contour is level, or practically so, the number of manholes will depend upon the number of bends, and the distance involved. It is not in keeping with good practice to space manholes more than 600 feet apart. Generally, the demands of the system require much closer spacing than the figure given. Where there are grades the location of manholes must be chosen accordingly, and before a wise choice can be made, a complete survey is necessary. The survey should include accurate data as to grade levels, location of existing and prospective water and gas mains, and sewer connections, as well as the nature of the soil to be encountered during construction.

It is important to keep in mind that the distance between centers of cables entering a manhole should be governed by the space necessary to make a splice. When this item is overlooked, great annoyance and inconvenience follow, not to mention the liability of serious burn-outs due to crowding of the cables within the manhole. A barrier system is practicable where the number of cables is not too great to permit convenient handling of all the cables.

Fig. 1 shows the general construction of a manhole built of reinforced concrete. There are two divisions, or practically two manholes in one, forming a duplicate system. An accident to one side is prevented from reaching the other, and therefore prevents a total shutdown, as far as local trouble is concerned. Here the cables are grouped in pairs, which makes it convenient in classifying them, and affords more immediate identification when making tests and repairs.

Where it is more expedient to construct a single manhole the cables may be laid in split tile, and cemented, forming a continuous duct system, the two groups taking the form shown in plan in Fig. 2. The chief point to be observed in placing cables in the position shown is to avoid sharp bends at the entrance of the ducts *B*.

An installation as shown in Fig 3 is highly objectionable: (1) on account of exposure of all cables to a burn-out on any one cable; (2) short radius

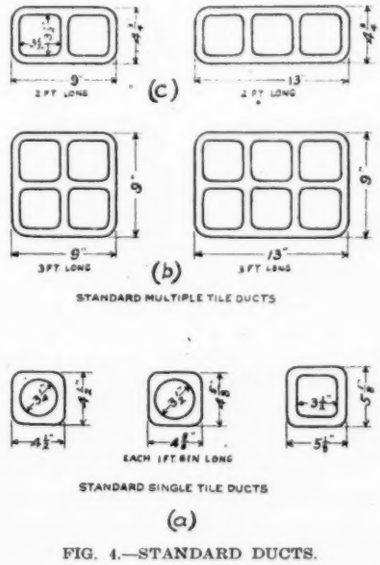


FIG. 4.—STANDARD DUCTS.

bends are required, to keep the cables separated; (3) unfavorable conditions for inner cables to radiate heat.

Where three or more cables are placed in one row it becomes clear that the objections above cited are greatly augmented. This form of construction is

to be found in a number of the older systems. An improvement could be added to it in most cases, without much extra cost, and thereby increase the safety of many old systems. This improvement consists in the placing of a short barrier wall, or slab, between the groups, at opposite sides of the manhole, as shown at *B*. This arrangement permits bends of a longer radius, unless the manhole is too small to allow shortening the radius of the bends *S* on either side. It will be found that such an improvement is feasible in the majority of cases referred to. The slab should be removable so as not to interfere with making splices or performing any work on the cables.

It is well to note the importance of having manholes large enough to allow at least two workmen to make repairs and installations comfortably. Present practice requires a minimum floor dimension of five feet, and it may be said that six or eight feet is far better. The inside height should be at least five feet, and six feet as a rule. This dimension may be increased where there are large groups of cables to handle. Local conditions alone will determine how far to extend beyond the minimum figures.

Single vs. Multiple Duct.—The usual dimensions of single tile duct are as shown in Fig. 4 (*a*). The square hole has the advantage of offering less friction to the cable when pulling in than with the round hole. Furthermore, there is a greater area of cross section available in the square hole for a number of cables. It should be stated, however, that the ducts should be limited to one cable each, unless the cables are small, and of low potential. The only advantage of having several cables in one duct is that the duct space becomes utilized. On the other hand, it is never advisable to have the openings completely filled. There should be sufficient air space around the cables to offer ventilation, otherwise the heat is stored up and cannot readily be disposed of. In Fig. 4, (*b*) and (*c*) show multiple ducts of two, three, four and six ducts respectively.

The chief advantage of multiple duct is that the labor, and hence the cost per duct foot, is less than in the case of single duct. The main disadvantage is that the joints cannot be staggered between single runs, as with the single duct. The single duct has another advantage on account of forming a double wall between cables, affording greater protection than with multiple duct.

(To be Continued.)

EDITOR'S NOTE.—This important series of articles started in the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN, September 3, 1910, and will cover every phase of central-station design. The treatment is elementary and withal practical throughout, and the complete series will constitute a standard and reliable treatise on this important subject.

The Generation of Power.

A lecture was delivered before the Franklin Institute of Pennsylvania on November 10 by Dr. D. S. Jacobus, advisory engineer of the Babcock & Wilcox Company, and formerly of the Stevens Institute of Technology, on "The Generation of Power." In this lecture the great developments of the art within the last few years were discussed, the subject treated from a scientific standpoint, in order to compare the failings and disadvantages of different means of generation, and a description given with numerous lantern slides of modern power plants and of marine practice.

The type of boiler best suited for power-plant work was fully discussed, the requirements as set forth being that while the boiler should be capable of operating economically at an ordinary load, it should also be capable of being driven to a capacity that is only limited by the amount of coal which can be burned in the furnace, and that it should be of a type which can be gotten under steam quickly and cut in line, either from a banked fire or from a cold state. He did not believe in adding to the water capacity to increase the thermal storage factor to a degree which would sacrifice the ability to get up steam quickly, as an increase in the thermal storage capacity could improve matters but little for the conditions to be met in ordinary power-plant work compared with the ability to get a reserve boiler in on the line in the shortest possible time. The best boilers to use are those which will respond quickly, and by having a number of the boilers in the plant under steam and others in reserve the steam pressure may be maintained practically constant. To make thermal storage a material factor the steam pressure must fall twenty-five pounds or so, and after the pressure falls, the thermal storage will act against the recovery of the pressure and the rate of combustion of the fuel and the heat imparted to the boilers must be greater than with the boilers having a less thermal capacity.

The great problem in power-plant engineering is to carry economically enough reserve capacity to meet the daily peaks of the load. Then again, there are exceptional peaks which only occur at rare intervals, so that a considerable percentage of the available power may be developed only for a few hours every month, or, for that matter, for a few hours every year.

The progress in this direction is exemplified by the installation of the Commonwealth Edison Company at Chicago, where the first 5,000-kilowatt turbines erected in this country were installed. This was in 1903, and eight boilers, each having about 5,000 square feet of heating surface, were supplied for running a turbine. The maximum rating for these turbines was 7,500 kilowatts. Later on, 12,000-kilowatt (maximum rating) turbines were installed, each with eight boilers of the same size as provided for the 5,000-kilowatt machines. Still later machines of 14,000-kilowatt maximum were run with the same size and number of boilers as the original machines of 7,500-kilowatt maximum.

The steam turbine is becoming more and more the standard for large-power-plant work both on account of its fuel economy and the low cost of attendance. The most economical fuel consumption under operating conditions that has so far been published was secured in a test with piston engines where a kilowatt-hour was turned out of the station for each 25,000 British thermal units contained in the fuel. The plant referred to is the Redondo plant of the Pacific Light & Power Company of California. The fuel was California crude oil. The load curve had two high peaks and there was a lay-over period of 4.5 hours per day during which the entire plant was shut down.

While no results for plant economy as good as the above have been published for steam turbines, it is only fair to say that the figures for water consumption for turbines show that better than this economy can be secured under uniform load conditions. When it comes to plant economy, so much depends on the load conditions that it is hard to compare one plant directly with another.

ELECTRIC LIGHTING and ILLUMINATING ENGINEERING

NEW LIGHTING OF MICHIGAN BOULEVARD, CHICAGO.

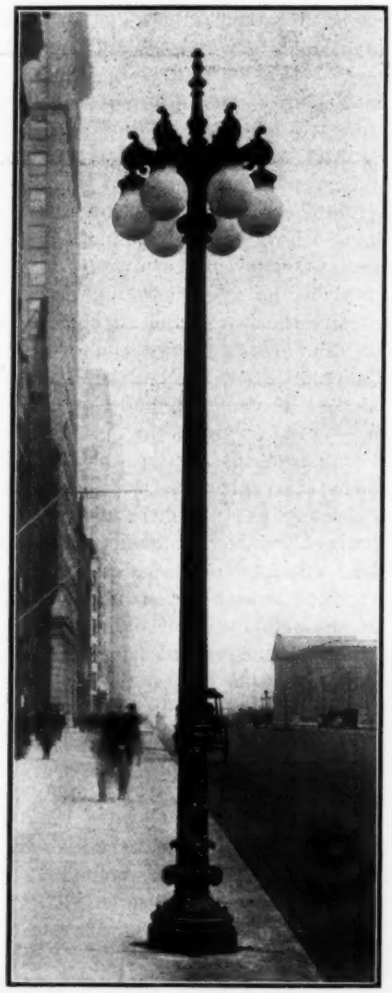
A SPLENDID EXAMPLE OF TUNGSTEN CLUSTER LIGHTING.

Arrangements have been practically completed for what will doubtless be the most splendid installation of street or boulevard lighting by means of clusters of tungsten lamps that has yet been attempted anywhere on a permanet and artistic scale. This installation will be made along Michigan Boulevard in Chicago and will probably be completed early next spring.

The section of Michigan Boulevard involved is that along the western edge of Grant Park between Randolph and Twelfth Streets and is about one and one-sixth miles in length. With a magnificent line of office structures, hotels, theaters, club houses and other fine commercial and public buildings fronting upon it, this portion of the boulevard forms the most imposing street in Chicago. In fact, there are but few streets in the world where one can get so fine a vista of modern architectural structures as along Michigan Boulevard viewed from Lake Michigan or from Grant Park.

This boulevard is always crowded with automobiles and other pleasure vehicles because of its proximity to the downtown district and because it forms the principal driveway leading from the center of the city to the extensive park and boulevard system of the South Side. On account of this dense traffic Michigan Boulevard was widened and repaved between Randolph and Twelfth Streets within the last two years. The roadway has now a width of seventy-five feet and is flanked by sidewalks of thirty and twenty-five feet width, thus making the total width of the boulevard 130 feet.

In making the improvements it was realized that the old open arc lamps formerly in use provided a lighting that was not only inadequate but unsuited to the character that the boulevard had assumed. The South Park Commissioners, who have jurisdiction over this boulevard, therefore, invited trial installations of a block or so each from manufacturers of various types of illuminants. Among the lamps so tried out were upright and inverted mantle gas lamps, open and inclosed carbon arc lamps, magnetite arcs, flaming arcs of both orange and white varieties, and tungsten incandescents in clusters of five lamps. The latter were mounted on adjustable wooden supports so that the spacing of the columns and the height and arrangement of the cluster that would give the best results could be determined. Although no elaborate illumination tests were made in these experiments, which were prolonged for many months, it was felt that the use of tungsten clusters would provide the most desirable quality of light and an abundant quantity with suitable distribution. Other considerations in the choice of this system were its efficiency, the elimination of lamp trimming, the fact that the burning out of any one lamp is not noticeably detrimental to the lighting effect, and finally the readiness with which it lends itself to artistic treatment.



PRELIMINARY MODEL OF NEW LIGHTING STANDARDS FOR MICHIGAN BOULEVARD.

The last consideration was an important one in view of the strong hold that the "city beautiful" movement has taken in Chicago. In the park and boulevard system it has found its most marked expression and it is but natural that the most important boulevard of the city be lighted by means of an equipment that not only satisfies esthetic requirements but will become a model of artistic street lighting. For this reason much care was taken in the selection of the type of standards to support the lamp clusters. After a number of designs were considered, the one shown herewith in its preliminary form was chosen.

Although the model shown in the illustration does not show the finer details of the design, some of these having not been worked out, it does show that the standards will be of distinctive and pleasing character. This unique design may be described as a freely interpreted classic, symbolic of the modern Renaissance school. The ornamentation is rich and pleasing and the entire effect will be strikingly beautiful both by day and by night.

The tungsten clusters employed in the trial installation were of the popu-

lar five-lamp type with a central top lamp inverted and four lamps suspended from brackets. As a considerable portion of the light flux from the inverted top lamp is wasted in an upward direction, it was determined to place all the lamps in a pendent position so as to secure a maximum of useful flux. Each standard will therefore bear six 100-watt tungsten lamps suspended from independent arms so that the centers of the lamps will be fifteen feet, five inches from the sidewalk. Each lamp will be enclosed in a twelve-inch Alba glass globe. The total height of the standard will be nineteen feet, two inches.

The standards will be placed near the curb line and directly opposite each other on the two sides of the boulevard. The spacing has not been exactly determined but will probably be about eighty feet between adjacent columns. In the original order 130 columns are to be provided for the section of the boulevard in question; if the eighty-foot spacing is adhered to the number of standards will have to be increased. The average length of the fourteen blocks in this stretch is a little over 400 feet.

Both on account of the great width of the boulevard and its density of traffic, it has been found necessary to place safety islands in the center of the roadway at the principal crossings. These are cement platforms slightly raised above the roadway and serve to separate the traffic in the north and south directions, aid the pedestrian in crossing by forming a shelter where he can pause to look in the opposite direction, and prevent swiftly moving automobiles from "cutting" around corners. To make these islands of value at night they are provided with a column bearing a red lamp.

Various designs of these columns have been in use along Michigan Boulevard. To secure uniformity and also harmony with the proposed curb lighting, a new design was selected which conforms to the new cluster standards, but is of a still more ornate character on account of the conspicuous location of the island columns. These columns will have a tripod base and will be surmounted by an inverted sixty- or 100-watt tungsten lamp inclosed in a large ruby Coral glass globe, the center of the lamp being close to eleven feet above the pavement. One hundred of these new columns have been ordered for use along Michigan Boulevard and in other parts of the South Park system.

The new cluster standards and island columns were designed by D. H. Burnham and Company, architects, Chicago. They are being cast by the Dearborn Foundry Company, of Chicago. The installation will be made under the supervision of J. F. Foster, superintendent of the South Park system.

Publication of the Johns Hopkins Lectures on Illuminating Engineering.

Considerable headway has been made in getting into shape for printing the lectures on illuminating engineering that were given at Johns Hopkins University, Baltimore, between the dates of October 26 and November 8, 1910. This lecture course was given under the joint auspices of the university and of the Illuminating Engineering Society. It was attended by 234 persons, who enthusiastically declared it to be the most thorough discussion of all branches of the science and art of illuminating engineering ever attempted. There has been much inquiry as to how copies of the lectures may be secured and on what terms.

Subscriptions for the printed volumes of the lectures will be received from anyone. Members of the Illuminating Engineering Society and those who attended the lectures will be entitled to receive one set of the lectures at the actual cost of publication. All other subscribers will be charged slightly in excess of this, so as to cover the incidental expenses in connection with publishing a much larger edition than is called for by the immediate and preferred subscribers. Any of the corporations that sent delegates to attend the lectures is entitled to receive an unlimited number of the volumes at the cheaper rate. All those entitled to receive the books at the lower rate must subscribe for them before December 15, 1910. Orders should be addressed to the Johns Hopkins University, Baltimore, Md., and should state whether the subscriber is a member of the Society or attended the lectures. No money need be sent with the subscriptions, as the cost, although probably about $5 a set, has not been exactly determined. Each set will consist of two volumes of about 700 pages each.

Philadelphia Section, National Electric Light Association.

The regular monthly meeting of the Philadelphia Electric Company Section, National Electric Light Association, was held in the Assembly Room at 1000 Chestnut Street, on the evening of November 21. There was an attendance of 127 members. Reports were heard from all the standing committees, particular interest being shown in the report of the Committee on the Awarding of Prizes, who awarded a first and third prize for suggestions received covering the betterment of company conditions. The two suggestions covered commercial propositions bearing particularly upon the relationship between the company and the consumer.

The award of the prizes was followed by the presentation of the revised constitution. The only material change is that provisions are made for departmental branches of the Philadelphia Electric Company Section, each branch to be confined to some particular line of work. At this time applications have been received from the meter department, the accounting department, and the commercial department, for the formation of branches, which it is hoped will be in operation before the first of January.

The papers of the evening were "The Possibilities of Electricity," by Jas. H. Dentry, and "The Increasing Prominence of Illuminating Engineering as Recognized by Technical Societies and Universities," by G. Bertram Regar.

The first paper was particularly interesting, being a historical review of the electrical industry from its infancy, tracing its progress through the various stages of the development of its application to lighting, heating, power, wireless telegraphy, etc. The paper was beautifully illustrated with lantern slides, and was very enthusiastically received.

The second paper was a brief outline of the work accomplished at Baltimore at the recent convention of the Illuminating Engineering Society, and also the course of lectures at the Johns Hopkins University, held under the auspices of the Society. The paper was very brief, but it is hoped at an early date to devote more time to this question, as even the brief outline proved most interesting and brought forth many questions.

TELEPHONY—TELEGRAPHY, and WIRELESS.

THE PERIODICITIES AND DAMPING COEFFICIENTS OF COUPLED OSCILLATORS.[1]

BY JOHN S. STONE.

The theory of two coupled oscillators, which is of great importance, particularly to the wireless-telegraph engineer, has been extensively treated by a number of writers including V. Bjerknes[2], Oberbech[3], Galitzin[4], Domalip and Kolácek[5], Wein[6] and Drude[7].

The expressions for the coefficients of damping and the periodicities of two coupled oscillators are found to depend upon the solution of an algebraic equation of the fourth degree, and for this reason it has become necessary to adopt simplified, approximate expressions for these quantities. Unfortunately the assumptions made in order to deduce these simplified expressions for the damping coefficients and periodicities of the coupled oscillators have been inconsistent with the conditions which prevail in most, if not all, practical applications of such oscillations. The resulting simplified expressions apply only to two coupled oscillators with little or no damping, or to cases in which the coupling is very slight, or to cases in which both the coupling and damping are very small.

In what follows we shall deduce expressions for the damping coefficients and periodicities of two coupled oscillators which, while convenient for purposes of computation, will yield correct results in all practical cases and which may be readily tested in any given case to determine their degree of approximation. Incidentally also we shall deduce expressions for the effective values of the inductance and resistance of coupled oscillators, expressions which correspond in a way to the expressions for the effective inductance and resistance of the primary circuits of alternating-current transformers as effected by the currents in their secondaries.

Let the resistance, inductance and capacity of the two oscillators be R_1, L_1, C_1, and R_2, L_2, C_2, respectively.

When the two oscillators are isolated, the equations for the natural oscillations of the charges of the two condensers are

$$\left(\frac{d^2}{dt^2} + 2\alpha_1 \frac{d}{dt} + p_1^2\right) Q_1 = 0$$

and

$$\left(\frac{d^2}{dt^2} + 2\alpha_2 \frac{d}{dt} + p_2^2\right) Q_2 = 0$$

where

$$\alpha = \frac{R}{2L}.$$

$$p^2 = \frac{1}{CL}$$

By substituting the particular solution

$$Q = \epsilon^{wt}$$

in these equations we get the equations for the dampings and natural periodicities.

$$\left.\begin{aligned} w_1^2 + 2\alpha_1 w_1 + p_1^2 = 0 \\ w_2^2 + 2\alpha_2 w_2 + p_2^2 = 0 \end{aligned}\right\} \quad (1)$$

from which

$$w_1 = -\alpha_1 \pm \beta_1 \sqrt{-1}$$

$$w_2 = -\alpha_2 \pm \beta_2 \sqrt{-1}$$

where

$$\beta_1 = \sqrt{p_1^2 - \alpha_1^2}$$

and

$$\beta_2 = \sqrt{p_2^2 - \alpha_2^2}$$

By combining particular solutions of the form $A\epsilon^{wt}$, the expressions for Q_1 and Q_2 when α_1 and α_2 are less than p_1 and p_2 will be found to be

$$Q_1 = \epsilon^{-\alpha_1 t}(A_1 \cos \beta_1 t + B_1 \sin \beta_1 t)$$

$$Q_2 = \epsilon^{-\alpha_2 t}(A_2 \cos \beta_2 t + B_2 \cos \beta_2 t)$$

where A_1, B_1, A_2 and B_2, are constants determined by the special conditions under which the natural oscillations are set up. We may digress here to note that the alphas are called the damping coefficients, the betas are called the natural periodicities or the periodicities of the natural oscillations and the p's are called the free periodicities or the periodicities of the free oscillations. The periodicity or pulsation β is 2π times the frequency of the oscillations. The natural oscillations are the oscillations which the oscillator actually executes when its electrical equilibrium is disturbed and it is permitted to restore itself to equilibrium in the absence of any impressed force. The free oscillations are the oscillations which the oscillator would execute in tending to restore its equilibrium if it were devoid of resistance or other damping action.

We are not here concerned with the case of non-oscillatory circuits, namely, those in which p_1 and p_2 are equal to or less than α_1 and α_2.

Coming now to the case of the two oscillators when brought into inductive relation with each other we have and

$$\left.\begin{aligned} \left(\frac{d^2}{dt^2} + 2\alpha_1 \frac{d}{dt} + p_2^2\right) Q_1 + \mu_1 \frac{d^2}{dt^2} Q_2 = 0 \\ \left(\frac{d^2}{dt^2} + 2\alpha_2 \frac{d}{dt} + p_2^2\right) Q_2 + \mu_2 \frac{d^2}{dt^2} Q_1 = 0 \end{aligned}\right\} \quad (2)$$

where

$$\mu_1 = \frac{M}{L_1}$$

$$\mu_2 = \frac{M}{L_2}$$

M being the mutual inductance between the circuits. The function

$$\sqrt{\mu_1 \mu_2} = \frac{M}{\sqrt{L_1 L_2}}$$

is called the coefficient of coupling.

From equations (2) we get

$$\left[\left(\frac{d^2}{dt^2} + 2\alpha_1 \frac{d}{dt} + p_1^2\right)\left(\frac{d^2}{dt^2} + 2\alpha_2 \frac{d}{dt} + p_2^2\right) - \mu_1 \mu_2 \frac{d^4}{dt^4}\right] Q = 0$$

$$\left[(1 - \mu_1 \mu_2)\frac{d^4}{dt^4} + 2(\alpha_1 + \alpha_2)\frac{d^3}{dt^3} + (p_1^2 + p_2^2 + 4\alpha_1 \alpha_2)\frac{d^2}{dt^2} + 2(\alpha_2 p_1^2 + \alpha_1 p_2^2)\frac{d}{dt} + p_1^2 p_2^2\right] Q = 0$$

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1 Paper read at meeting of Society of Wireless Telegraph Engineers, October 8, 1910.

2 Wied. Ann. 55, p. 121, 1895.

3 Wied. Ann. 55, p. 623, 1895.

4 Petersb. Ber., May and June, 1895.

5 Wied. Ann., 57, p. 731, 1896.

6 Wied. Ann. 61, p. 151, 1897. Ann. d. Physik. 8. p. 686, 1902.

7 Ann. d. Physik. 13, p. 512, 1904.

By substituting the particular solution

$$Q = \epsilon^{mt}$$

in this equation we get the equation for the dampings and natural periodicities of the inductively associated oscillators

$$m^4 + 2\frac{a_1 a_2}{k} m^3 + \frac{p_1^2 + p_2^2 + 4a_1 a_2}{k} m^2 + 2\frac{a_1 p_2^2 + a_2 p_1^2}{k} m + \frac{p_1^2 p_2^2}{k} = 0 \quad (3)$$

where

$$k = 1 - \mu_1 \mu_2$$

The complete solution of this quartic is too involved to be of any practical use to the engineer, but by a simple device a solution may be obtained which besides lending itself to use for the purposes of computation also gives a close degree of approximation even in the case of oscillators having a high degree of damping or a high degree of coupling or both.

When $k = 1$, that is to say, when the mutual inductance between the oscillators vanishes, equation (3) reduces to

$$m^4 + 2(a_1 + a_2)m^3 + (p_1^2 + p_2^2 + 4a_1 a_2)m^2 + 2(a_1 p_2^2 + a_2 p_1^2)m + p_1^2 p_2^2 = 0$$

This equation is naturally the same as the product of the two equations (1) and has the same solution as these equations.

Equation (3) may be written in the form

$$m^4 + 2(a_1 + a_2)m^3 + (q_1^2 q_2^2 + 4a_1 a_2)m^2 + 2(a_1 q_2^2 + a_2 q_1^2)m + q_1^2 q_2^2 = 0 \quad (4)$$

where

$$\left.\begin{aligned} k(a_1 + a_2) &= a_1 + a_2 \\ k(q_1^2 + q_2^2 + 4a_1 a_2) &= p_1^2 + p_2^2 + 4a_1 a_2 \\ k(a_1 q_2^2 + a_2 q_1^2) &= a_1 p_2^2 + a_2 p_1^2 \\ k q_1^2 q_2^2 &= p_1^2 p_2^2 \end{aligned}\right\} \quad (5)$$

This is the equation for the dampings and natural periods of two new oscillators which, when isolated, have the same dampings and natural periods as the two oscillators we are considering have when in inductive relation to each other.

The second of equations (5) may be written in the form

$$k(q_1^2 + q_2^2)\left(1 + 4\frac{a_1 a_2}{q_1^2 + q_2^2}\right) = (p_1^2 + p_2^2)\left(1 + 4\frac{a_1 a_2}{p_1^2 + p_2^2}\right)$$

and reduces to

$$k(q_1^2 + q_2^2) = p_1^2 p_2^2$$

when

$$\frac{1 + 4\frac{a_1 a_2}{p_1^2 + p_2^2}}{1 + 4\frac{a_1 a_2}{q_1^2 + q_2^2}} = 1 \quad (6)$$

This condition is either true or very closely approximated in all practical cases even where the oscillators are heavily damped or closely coupled. In any case of doubt the criterion (6) may be applied and the degree of approximation of the assumption ascertained.

With this modification of the second equation the group (5) gives

$$\left.\begin{aligned} q_1^2 &= \frac{d + \sqrt{d^2 - 4f}}{2} \\ q_2^2 &= \frac{d - \sqrt{d^2 - 4f}}{2} \end{aligned}\right\} \quad (7)$$

$$\left.\begin{aligned} a_1 &= \frac{e - c q_1^2}{q_2^2 - q_1^2} = \frac{c q_2^2 - e}{\sqrt{d^2 - 4f}} \\ a^2 &= \frac{e - c q_2^2}{q_1^2 - q_2^2} = \frac{e - c q_2^2}{\sqrt{d^2 - 4f}} \end{aligned}\right\} \quad (8)$$

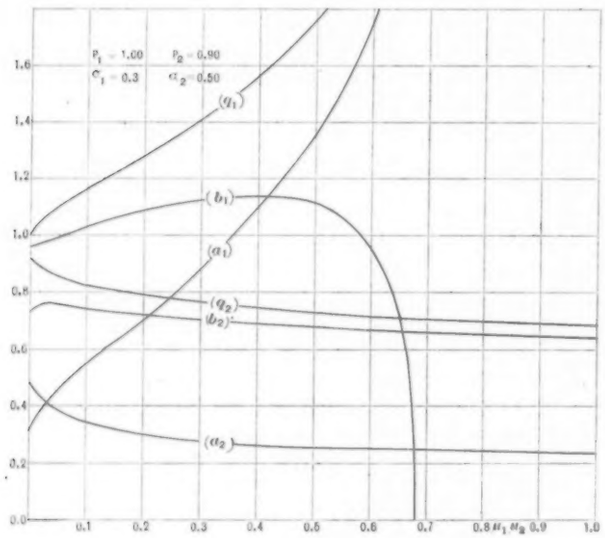


FIG 1.

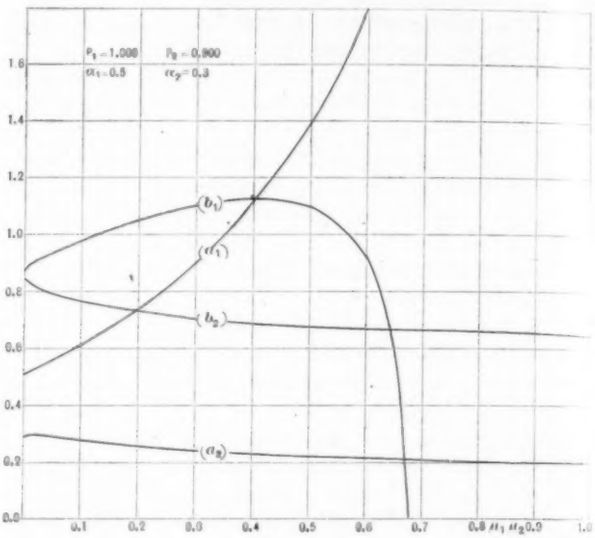


FIG. 3.

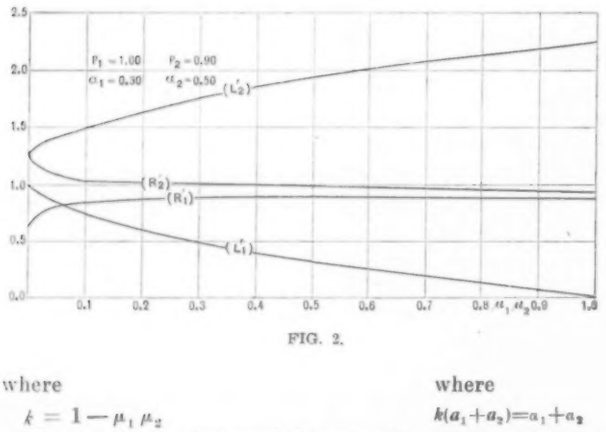


FIG. 2.

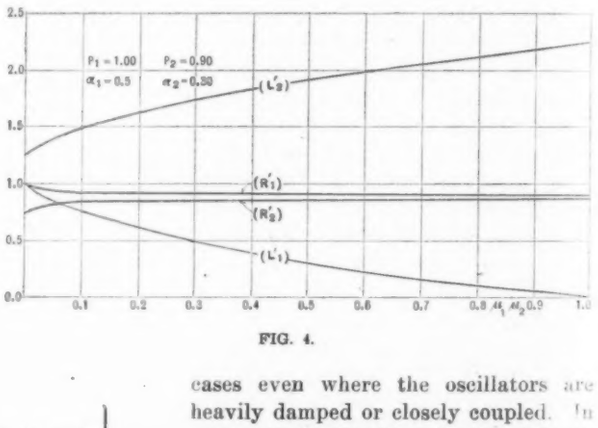


FIG. 4.

where

$$c = \frac{a_1 + a_2}{k}$$

$$d = \frac{p_1^2 + p_2^2}{k}$$

$$e = \frac{a_1 p_2^2 + a_2 p_1^2}{k}$$

$$f = \frac{p_1^2 p_2^2}{k}$$

$$a_2 = \left.\begin{aligned} &\frac{a_1 p_2^2 + a_2 p_1^2 - (a_1 + a_2) q_2^2}{k (q_1^2 - q_2^2)} \\ &= \frac{a_1 p_2^2 + a_2 p_1^2 - (a_1 + a_2) q_2^2}{\sqrt{p_1^2 + p_2^2)^2 - 4 k p_1^2 p_2^2}} \\ &= \frac{a_1 p_2^2 + a_2 p_1^2 - (a_1 + a_2) q_2^2}{\sqrt{p_1^2 - p_2^2 + 4\mu_1\mu_2 p_1^2 p_2^2}} \end{aligned}\right\} \quad (11)$$

Since equation (4) is the product of the two quadratics

$$m^2 + 2a_1 m + q_1^2 = 0$$
$$m^2 + 2a_2 m + q_2^2 = 0$$

its solution is evidently

$$m = -a_1 \pm b_1\sqrt{-1}$$

and

$$m = -a_2 \pm b_2\sqrt{-1}$$

where

$$b_1 = \sqrt{q_1^2 - a_1^2}$$
$$b_2 = \sqrt{q_2^2 - a_1^2}$$

From the foregoing it will be seen that a_1 and a_2 are the damping coefficients, q_1 and q_2 the free periodicities and b_1 and b_2 are the natural periodicities of the coupled oscillators so that we have for the solution of equations (2)

$$Q_1 = A_1 \epsilon^{-a_1 t} \sin(b_1 t + \theta_1) + B_1 \epsilon^{-a_2 t} \sin(b_2 t + \theta_2)$$
$$Q_2 = A_2 \epsilon^{-a_1 t} \sin(b_1 t + \phi_1) + B_2 \epsilon^{-a_2 t} \sin(b_2 t + \phi_2)$$

where

$$A_1,\ B_1,\ \theta_1,\ \phi_1,\ A_2,\ B_2,\ \theta_2,\ \phi_2$$

are constants which are determined by means of equation (2) and the boundary conditions.

Equations (7), (8), (9), (10) and (11) may be thrown into such form as to give the effective values of the inductance of the coupled circuits, for writing

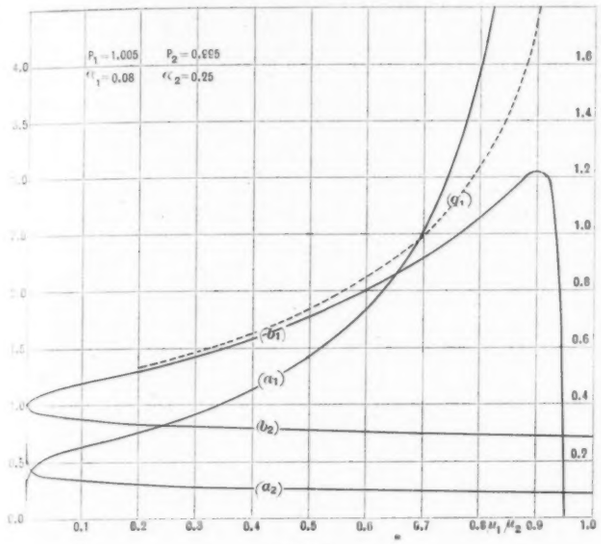


FIG. 5.

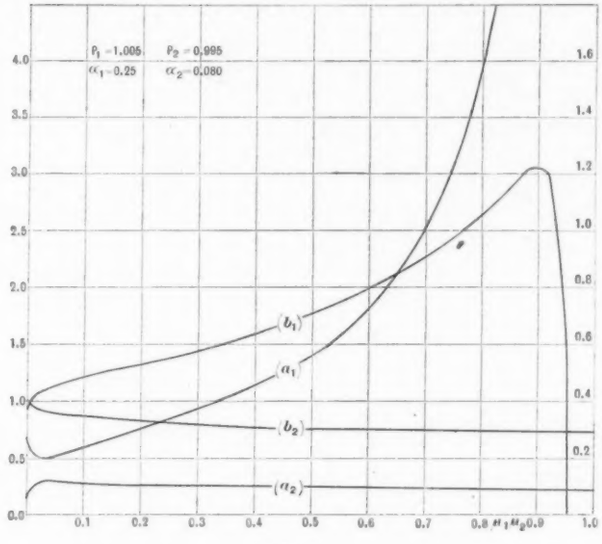


FIG. 7.

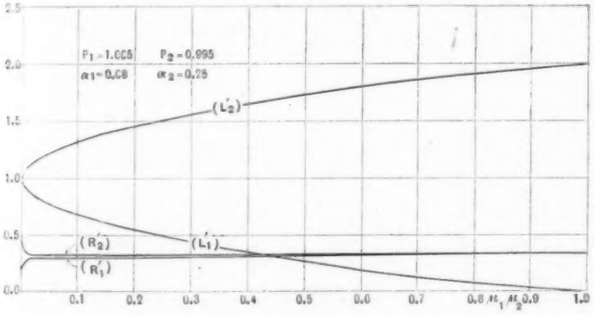


FIG. 6.

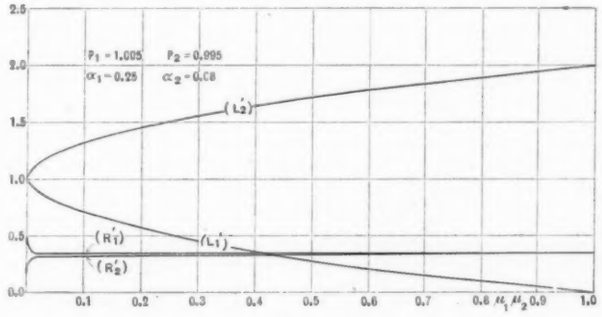


FIG. 8.

In their expanded form these expressions are

$$\left.\begin{aligned} q_1^2 &= \frac{p_1^2 + p_2^2 + \sqrt{(p_1^2 + p_2^2)^2 - 4k p_1^2 p_2^2}}{2k} \\ q_2^2 &= \frac{p_1^2 + p_2^2 - \sqrt{(p_1^2 + p_2^2)^2 - 4k p_1^2 p_2^2}}{2k} \\ q_1^2 &= \frac{p_1^2 + p_2^2 + \sqrt{(p_1^2 - p_2^2)^2 + 4\mu_1\mu_2 p_1^2 p_2^2}}{2(1 - \mu_1\mu_2)} \\ q_2^2 &= \frac{p_1^2 + p_2^2 - \sqrt{(p_1^2 - p_2^2)^2 + 4\mu_1\mu_2 p_1^2 p_2^2}}{2(1 - \mu_1\mu_2)} \end{aligned}\right\} (9)$$

$$\left.\begin{aligned} a_1 &= \frac{a_1 p_2^2 + a_2 p_1^2 - (a_1 + a_2) q_1^2}{k (q_2^2 - q_1^2)} \\ &= \frac{(a_1 + a_2) q_1^2 - (a_1 p_2^2 + a_2 p_1^2)}{\sqrt{(p_1^2 + p_2^2)^2 - 4 k p_1^2 p_2^2}} \\ &= \frac{(a_1 + a_2) q_1^2 - (a_1 p_2^2 + a_2 p_1^2)}{\sqrt{(p_1^2 - p_2^2)^2 + 4\mu_1\mu_2 p_1^2 p_2^2}} \end{aligned}\right\} (10)$$

$$q_1^2 = \frac{1}{L_1' C_1}$$
$$q_2^2 = \frac{1}{L_2' C_2}$$

makes L'_1 and L'_2 the effective values of the inductances of the coupled circuits or the inductances which the circuits must have when isolated in order to possess the same free periodicities as those which they have when coupled.

The expanded forms of these expressions are

$$L_1' = L_1 \frac{2\left(1 - \frac{M^2}{L_1 L_2}\right)}{1 + \frac{C_1 L_1}{C_2 L_2} + \sqrt{\left(1 - \frac{C_1 L_1}{C_2 L_2}\right)^2 + 4\frac{M^2 C_1 L_1}{L_1 L_2 C_2 L_2}}}$$

$$L_2' = L_2 \frac{2\left(1-\frac{M^2}{L_1L_2}\right)}{1+\frac{C_2L_2}{C_1L_1}-\sqrt{\left(\frac{C_2L_2}{C_1L_1}-1\right)^2+4\frac{M^2C_2L_2}{L_1L_2C_1L_1}}}$$

Similarly expressions may be obtained for the effective resistances of the coupled oscillators, for writing

$$a_1 = \frac{R_1'}{2L_1'}$$

$$a_2 = \frac{R_2'}{2L_2'}$$

makes R'_1 and R'_2 the effective values of the resistances of the coupled oscillators since these are the values of the resistances which together with the effective values of the inductances and the real values of the capacities would give the oscillators when isolated the same coefficients of damping and natural periodicities as they possess when coupled. The expressions for R'_1 and R'_2 are

$$R_1' = \frac{2a_2}{C_1 q_1^2}$$

$$R_2' = \frac{2a_1}{C_2 q_2^2}$$

In their expanded form these expressions are unwieldy.

C_1, C_2, L'_1, L'_2, R'_1, R'_2 are the capacities, inductances and resistances of two circuits which when isolated have the same dampings, free periods and natural periods as the circuits under consideration have when coupled. In other words R'_1, R'_2 and L'_1, L'_2 are the *apparent resistances* and *inductances* of the coupled circuits, each for the

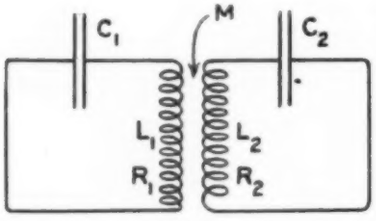


FIG. 9.

damped oscillations of its own natural periodicity as affected by the presence of the other circuit.

When in any case it is desired to increase the degree of approximation beyond that given by equations (7) and (8) this may readily be done by first computing a_1 and a_2 by means of (7) and (8) and then making use of these values of a_1 and a_2 in the following expressions:

$$q_1^2 = \frac{g+\sqrt{g^2-4f}}{2}$$

$$q_2^2 = \frac{g-\sqrt{g^2-4f}}{2}$$

$$a_1 = \frac{cq_1^2-e}{\sqrt{g^2-4f}}$$

$$a_2 = \frac{e-cq_2^2}{\sqrt{g^2-4f}}$$

where

$$g = d+4\left(\frac{a_1a_2}{k}-a_1a_2\right)$$

These expressions are deduced directly from equation (5).

Figs. 1, 2, 3 and 4 show the effect of varying degrees of coupling upon the apparent inductances, apparent resist-

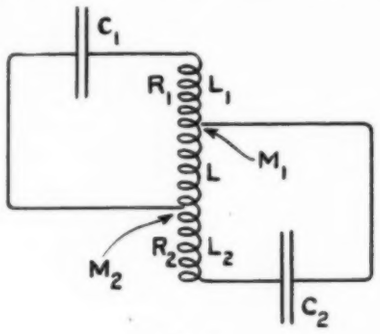


FIG. 11.

ances, damping coefficients, free periodicities, and natural periodicities of two very heavily damped oscillators, while Figs. 5, 6, 7 and 8 show the same thing in the case of two less heavily damped oscillators.

It is to be noted that the free periodicities q_1 and q_2 are quite different from the natural periodicities b_1 and b_2 in Fig. 1 and that the free periodicity q_1 differs materially from the natural periodicity b_1 in Fig. 5 at all but small couplings. The usual assumption that the free and the natural periodicities are substantially the same is therefore seen to be in error even when the damping is not large, provided the coupling is sufficiently great.

It is to be further noted in Figs. 1, 3, 5 and 7 that the higher natural periodicity b_1 only increases, for increases of the coupling coefficient, to a certain maximum value after which further increases in the coupling causes b_1 to rapidly diminish in value till it reaches zero, whereas the corresponding free periodicity q_1 goes on increasing for increases of coupling until at perfect coupling (k=o) this free periodicity is infinite.

The reason therefore that two perfectly coupled circuits have only one natural frequency of oscillation is that the circuit having the higher free periodicity has become aperiodic through its association with the other circuit. Moreover the curves for a_1 and q_1 show why the circuit having the higher free periodicity tends to become aperiodic for high values of the coupling. This is seen to be because the damping coefficient a_1 increases more rapidly than the free periodicity for high values of the coupling.

A careful inspection of these figures will reveal a number of interesting points such as the tendency of the apparent or effective resistances R'_1 and R'_2 to approach a common value for increases of the coupling and the fact that L'_1, the effective inductance of the circuit having the higher free periodicity diminishes in value for increases of coupling until at perfect coupling it becomes zero. It will not be possible in this paper, however, to further indicate or discuss the points brought out by these curves. Suffice it to draw attention to the choice of the constants p_1, p_2, a_1 and a_2 which divides the curves into four cases as follows:

	p_1	p_2	a_1	a_2
Figs. 1 and 2.....	1.00	0.90	0.30	0.50
Figs. 3 and 4.....	1.00	0.90	0.50	0.30
Figs. 5 and 6.....	1.005	0.995	0.08	0.25
Figs. 7 and 8.....	1.005	0.995	0.25	0.08

The case of Figs. 3 and 4 is the same as that of Figs. 1 and 2 except that values of the damping coefficients are reversed. In the same way the case of Figs. 7 and 8 is the same as that of Figs. 5 and 6 except that the values of the damping coefficients are reversed.

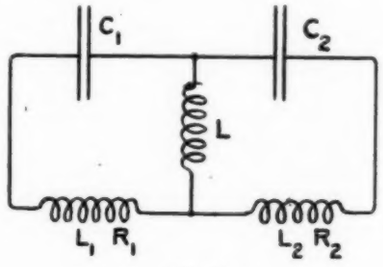


FIG. 10.

If the free periods of the oscillators are the same when the oscillators are isolated, that is, if

$$p_1^2 = p_2^2 = \frac{1}{CL_1} = \frac{1}{CL_2} = p^2$$

then

$$q_1^2 = \frac{p^2}{1-\sqrt{\mu_1\mu_2}}$$

$$q_2^2 = \frac{p^2}{1+\sqrt{\mu_1\mu_2}}$$

$$a_1 = \frac{(a_1+a_2)\ (q_1^2-p^2)}{2p^2\sqrt{\mu_1\mu_2}}$$

$$a_2 = \frac{(a_1+a_2)\ (p^2-q_2^2)}{2p^2\sqrt{\mu_1\mu_2}}$$

$$L_1' = L_1\left(1-\sqrt{\mu_1\mu_2}\right)$$

$$L_2' = L_2(1-\sqrt{\mu_1\mu_2})$$
$$R_1' = L_1\frac{(\alpha_1+\alpha_2)\ (q_1^2-p^2)\ (1-\sqrt{\mu_1\mu_2})}{p^2\sqrt{\mu_1\mu_2}}$$
$$R_2' = L_1\frac{(\alpha_1+\alpha_2)\ (p^2-q_2^2)\ (1+\sqrt{\mu_1\mu_2})}{p^2\sqrt{\mu_1\mu_2}}$$

This is a case of great theoretical interest and is one of considerable importance for the purpose of computation, though in the practical use of coupled oscillators they are never operated at exact unison of their isolated free periods p_1 and p_2, but on the contrary they are usually operated at unison or nearly unison of their coupled natural periods b_1 and b_2 with loose coupling, or they are operated at quite a different adjustment from either of these, an adjustment which gives a maximum of potential or current in one of the oscillators with fairly close coupling.

The preceding expressions have been deduced with respect to two inductively coupled circuits as shown in Fig. 9, but they may be made to apply to circuits which are conductively coupled as shown in Fig. 10 or to apply to circuits which are both conductively and inductively coupled as shown in Fig. 11, by assigning the proper values to the constants.

In the case of the conductive coupling shown in Fig. 10 the values of the constants are

$$\mu_1 = \frac{L}{L_1+L}$$
$$\mu_2 = \frac{L}{L_2+L}$$
$$\alpha_1 = \frac{R_1}{L_1+L}$$
$$\alpha_2 = \frac{R_2}{L_2+L}$$

In the case of the combined conductive and inductive coupling shown in Fig. 11 the values of the constants are

$$\mu_1 = \frac{L+M_1}{L_1+L+M}$$
$$\mu_2 = \frac{L+M_2}{L_2+L+M_2}$$
$$\alpha_1 = \frac{R_1}{L_1+L+M_1}$$
$$\alpha_2 = \frac{R_2}{L_2+L+M_2}$$

It is to be noted that in both cases shown in Fig. 9 and that shown in Fig. 10, the resistance of the coil which is common to the two circuits is taken as negligible. This is always the case in practical applications of such circuits since there is always a considerable source of dissipation of energy in each of the oscillators while the coupling coil has merely the resistance of its winding which is purposely made small.

The Illinois Central Extends its Telephone Dispatching System.

Ninety-nine miles of the Illinois Central Railroad between Paducah and Central City, Ky., have lately been equipped with telephone circuits for handling train orders. Already the telegraph has been supplanted for dispatching trains on more than 2,000 miles of this road. On the new circuit sixteen way-station subscriber sets have been installed in addition to twenty-one regular telephone stations.

These way stations are placed along the line in booths or buildings located at sidings or points where it is not necessary to station regular operators. Some of these stations were previously used as block telegraph offices. These sets, which are somewhat similar in appearance to the standard magneto telephone set, are for use in connection with hand sets equipped with plugs and cords. Each subscriber's set is equipped with a jack to enable connection to be made by means of a hand telephone.

The hand sets are numbered, and one is furnished each freight train conductor, when his train is ready to start out on a run. A receipt is taken from the conductor when the set is delivered, and the set is turned in when the conductor completes his run. To get into communication with the dispatcher the conductor goes into the booth, or stations, throws a switch which connects the telephone to the line and inserts the plug into the jack, thereby placing his receiver across the line. To speak to the dispatcher, it is necessary to press a button on the hand set which closes the transmitter circuit.

This system enables train crews to receive orders from the dispatcher when they are held awaiting delayed trains, or when emergencies arise making it necessary for the trains to go on a siding. Due to the simple method of operation and the fact that the hand sets are always turned over to the conductors in good condition, there is very little possibility of the equipments not being in good operating condition at all times. This constitutes an effective method of keeping in touch with freight trains at all points along the road. The apparatus has been manufactured and furnished by the Western Electric Company.

Telephone Insurance.

Fire insurance companies have just decided upon a material concession in rates on telephone-exchange property, including switchboards and other apparatus. Heretofore such personal property of telephone companies could be written only at annual rates except when in buildings occupied exclusively for office, telephone-exchange and dwelling purposes. This denied the concession usually allowed on term rates, under which property can be written for three years at two and one-half times the annual rate and for five years at four times the annual rate. This concession of term rates is now extended to telephone property contained in brick mercantile buildings, provided the building in which it is located is eligible for term insurance This amounts to a reduction in rates of sixteen and two-thirds per cent if the property is written for three years and twenty per cent if it is written for five years.

At first telephone property was insured only on the annual basis. The first concession was made when term rates were allowed, which was only when the building in which the contents were located was occupied exclusively for office, telephone-exchange and dwelling purposes. This latest concession extends term rates to brick building occupied for mercantile purposes, which includes the great majority of the smaller telephone-exchange properties.

California Company Creates Timber Department.

Seeing the value of carefully selecting and treating timber for poles, the San Joaquin Light & Power Company has created a timber department and erected a creosoting plant. The move has been contemplated for some time.

The Pacific Light & Power Company, of Los Angeles, which serves the San Joaquin Valley from Merced south is controlled by the same interests and will also take advantage of the new timber supply arrangements.

Tunnel Under the Seine River.

The tunnel which is being built under the Seine at Paris by the Metropolitan Railway Company is said to be the largest sub-aqueous tunnel in the world. Charles M. Jacobs and J. Vipond Davies are superintending the work of construction.

FINANCIAL REPORTS OF ELECTRICAL COMPANIES.

KANSAS CITY RAILWAY AND LIGHT.

The report of the Kansas City Railway and Light Company for the month of October and five months ended October 31, compares as follows:

	1910	1909
October gross	$ 693,420	$ 642,239
Expenses	413,920	359,915
October net	279,500	282,324
Charges and taxes	193,806	175,293
October surplus	85,694	107,031
Five months' gross	3,184,790	2,944,481
Expenses	1,902,094	1,666,415
Five months' net	1,282,696	1,278,066
Charges and taxes	943,532	865,630
Five months' surplus	339,164	412,436

MONTREAL STREET RAILWAY.

The report of the Montreal Street Railway Company for the month of October compares as follows:

	1910	1909
October gross	$ 386,687	$ 354,007
Expenses	205,750	174,735
October net	180,937	179,272
Charges and taxes	31,998	31,079
October surplus	148,939	148,193

TRI-CITY RAILWAY AND LIGHT.

The Tri-City Railway and Light Company has issued its report for the year ended September 30, 1910. The income account compares as follows:

	1910	1909
Gross earnings	$2,380,190	$1,973,756
Operating expenses	1,378,130	1,115,788
Net earnings	1,002,059	857,968
Interest on sinking fund	527,228	513,807
Surplus for dividends	474,831	344,161
Preferred dividend	169,572	169,572
Surplus	*305,259	174,589
*Equal to 3.39 per cent earned on common stock, compared with 1.94 per cent earned on same stock last year.		$9,000,000

NORTHERN OHIO TRACTION.

The report of the Northern Ohio Traction and Light Company for the month of October and ten months ended October 31, compares as follows:

	1910	1909
October gross	$ 208,342	$ 184,815
Expenses	113,371	100,800
October net	94,971	84,015
Charges	43,367	44,114
October surplus	51,604	39,901
Ten months' gross	2,045,748	1,818,987
Expenses	1,123,229	988,530
Ten months' net	922,519	830,457
Charges	433,528	437,456
Ten months' surplus	488,991	393,000

COMMONWEALTH EDISON COMPANY.

Gross earnings of the Commonwealth Edison Company in the year ended September 30, 1910, were $13,083,724, an increase over the previous year of $2,444,278, or 22.9 per cent. The aggregate of operating and selling expenses, taxes, and general expenses increased 27.0 per cent. The net income applicable to interest charges was $4,641,841, a gain of $645,088, or 16.2 per cent.

The year's depreciation reserve was $105,000 heavier than a year ago. The balance after this deduction applicable to dividends, was $2,842,834, or 9.08 per cent on the $32,272,100 capital stock issued at the end of the year. This compares with 7.95 per cent earned in 1909.

The income account compares as follows:

INCOME ACCOUNT.

Gross income	$13,083,724	$10,639,416
Operating expenses and taxes	8,441,883	6,642,693
Net income from all sources	$ 4,641,841	$ 3,996,753
Interest on bonds	1,266,918	1,182,507
Depreciation reserve	532,089	427,250
(Under the terms of the mortgages made by the Chicago Edison Company and the Commonwealth Electric Company.)		
Dividends paid	1,847,243	1,800,000
Total charges	$ 3,646,250	$ 3,409,757
Balance	995,590	586,996

BALANCE SHEET—ASSETS.

Plants, real estate, etc.	$63,643,076	$57,205,122
Open accounts	55,007	188,184
Material in storerooms	700,135	885,885
Coal in storage	122,012	*
Accounts and bills receivable	$ 1,771,023	$ 1,287,404
Cash	1,196,184	1,026,330
	$67,487,438	$60,584,984

LIABILITIES.

Capital stock—		
Stock issued	$32,272,100	$30,000,000
Advance payments for new stock authorized	449,797	
	$32,721,807	$30,000,000
Real estate mortgages	130,000	130,000
Bonds	27,635,000	24,662,000
Depreciation reserve	2,753,839	2,221,750
Accounts payable	453,198	783,519
Municipal compensation	146,876	122,468
Bonds interest accrued	153,219	224,042
Taxes accrued	468,000	411,388
Surplus account	3,025,407	2,029,818
	$67,487,438	$60,584,984

*Included in material.

INTERBOROUGH RAPID TRANSIT.

The earnings of the Interborough Rapid Transit Company for the month of October and four months ended October 31 compare as follows:

	1910	1909
Gross operating revenue	$2,547,654	$2,527,524
Operating expenses	981,748	919,601
Net operating revenue	1,565,906	1,607,823
Taxes	154,694	125,163
Income from operation	1 411,213	1,482,660
Other income	29,550	33,704
Total income	1,440,763	1,516,364
Interest, rent, etc., including Manhattan guarantee	904,812	858,042
Net corporation income	535,951	658,323
Passengers carried	49,543,316	49,144,215
July 1 to Oct. 31:		
Gross operating revenue	8,968,020	8,823,991
Operating expenses	3,727,518	3,451,998
Net operating revenue	5,240,501	5,371,992
Taxes	611,871	583,035
Income from operation	4,628,630	4,788,956
Other income	117,804	165,016
Total income	4,746,434	4,953,973
Interest, rentals, etc, including Manhattan guarantee	3,557,970	3,508,022
Net corporation income	1,188,464	1,445,951
Passengers carried	173,790,798	171,295,259

Dividend requirements for the quarter ended September 30, amount to $787,500.

The increase in operating expenses is largely due to extraordinary expenditures, the result of changes in subway equipment made necessary in connection with the operation of ten-car express and six-car local trains.

AMONG THE CONTRACTORS AND SUPPLY MEN

To know what is going on among the men who do things and those who supply the material for the doing is always interesting. The actual happenings of the day with the contractors and the men who furnish them with supplies of all kinds, accurately reported from all parts of the country, is the object of this department.

DUFFIELD & DIETZ, of Lock Haven, Pa., recently wired and installed electric lights in the home of L. W. Dornblaser, of that city.

JAMES GRAY, dealer in electrical fixtures has removed to 215 East James Street, Bloomington, Ill., and intends to incorporate in the near future under the firm name of The James Gray Electric Company. Z.

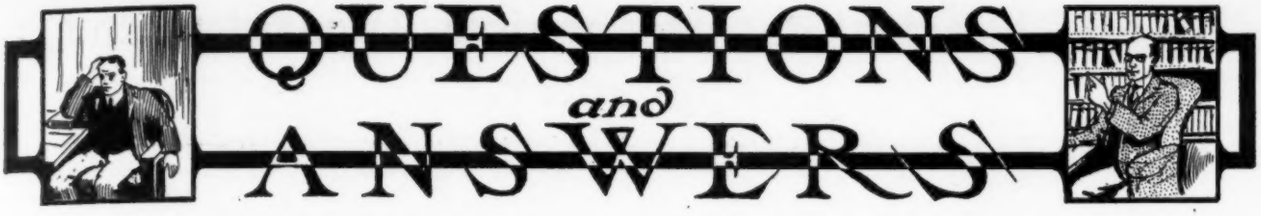
THE GRAPE BELT ELECTRICAL COMPANY, of Dunkirk, N. Y., has been incorporated with a capital stock of $3,000, and will deal in all forms of electrical appliances. The directors of the Company are John M. Winship and James H. Winship of Buffalo and Frank W. Houston of Dunkirk. T.

THE H. E. LOWE ELECTRIC COMPANY, Macon, Ga., has the contract to supply all electrical equipment needed for the new building to be constructed for *The Macon Telegraph*, the morning newspaper, whose building was recently destroyed by fire. The contract includes motors for operation of the presses and the linotype machines. B.

CLARENCE STANSBURY, Waterville, Me., received the contract from the Eastern Car Heater Company, of Boston, to install a fifty-horsepower engine at Hermon Center; also 120 incandescent lights and fifty tungsten lights on poles. The contract, which was for $900, calls for other work for the Company.

Michigan Properties Evaluated.

All properties of the Commonwealth and of the Consumers Power Companies of Michigan are being valued under the direction of Professor M. E. Cooley, dean of the engineering department of the university of that state. This work is being done at the instance of the Michigan Railway Commission for the purpose of authorizing an issue of capital similar to that for which the State Government has from time to time engaged Professor Cooley since the Michigan railway appraisals began in 1900.



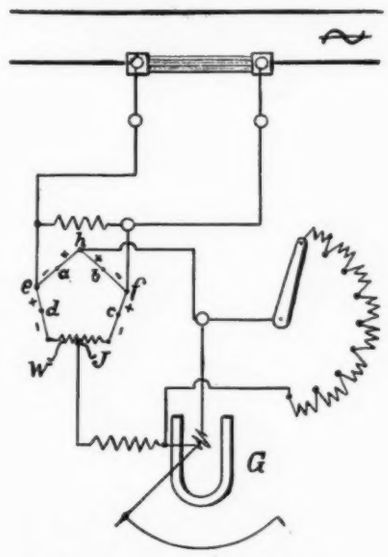
IRON HEATING COIL.—I wish to heat a cylinder of cast iron by winding iron wire around a pipe wrapped with asbestos, the pipe to be slipped into the cylinder through two one-and-one-half-inch holes. How much and what gauge iron wire shall I use, the heating coil to absorb about one-half kilowatt? How many calories will one kilowatt give a second?—F. G. D., Lincoln, Neb.

The problem does not state what length the coil may be, nor the temperature that is to be attained, nor the current that may safely be used on the circuit. Assuming a current of fifteen amperes, forty-two feet of No. 18 B & S iron wire will have a hot resistance of about 2.2 ohms and develop a temperature in the coil of approximately 450 degrees Fahrenheit. If the current and temperature are too high, the coil should be lengthened to fifty feet or more of wire. By using special resistance wire particularly designed for heating coils, of which there are several varieties on the market, the length of wire in the coil or the current needed may be reduced and the oxidation of the wire prevented. A kilowatt develops 240 calories per second.

FIXATION OF ATMOSPHERIC NITROGEN.—What is meant by fixation of nitrogen and how is it done?—S. H. C., Provo, Utah.

The fixation of nitrogen means the utilization of the nitrogen gas in the air for the manufacture of nitric acid, sodium or potassium nitrates, and other nitrogenous substances much used as fertilizers. This is not accomplished in one operation, but the first and most important step in each process is the oxidation of the free nitrogen into the form of nitric oxide, which can be done by means of high-voltage discharges across an air gap. The arcs produced raise the temperature of the air to such a high point that the nitrogen and oxygen unite. The nitric oxide produced is led away from the arcing point and cooled. It is then passed into water, caustic soda or potash, or other chemicals, depending on what product is desired.

GOSSEN MILLIVOLT AMMETER.—In the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN for November 12 there appeared an article on "The Gossen Precision Millivolt Ammeter for Alternating and Direct Currents." In discussing this instrument with some friends we were not able to see into certain points. Therefore kindly answer the following questions in reference to it: How is equal potential obtained at *J* and *h* by regulating the resistance shown at *W* in the diagram? Why are points *e* and *f* in that figure at the same potential? Why cannot the direct current generated by the thermocouples pass over the conductors carrying the alternating current to be measured?—W. C. D., Lexington, Ky.



GOSSEN MILLIVOLT AMMETER.

The simplest way to consider the action of the Gossen instrument is to regard the four bridge arms containing each a thermocouple as merely a means for rectifying a portion of the alternating electromotive force applied at the points *e* and *f*. This applied current divides in the two paths between *e* and *f* so that during one-half wave it flows in the direction *e h f* and *e J f* and the next half wave it flows in the direction *f h e* and *f J e*. In traversing the four arms it heats the thermocouples contained in each and these set up small local electromotive forces which in the arms *b* and *c* are in one direction and in the arms *a* and *b* in the opposite direction, but all these are directed toward the point *h* and away from *J* or the reverse. In each half of the bridge, therefore, the alternating current is slightly aided in one arm and slightly opposed in the other by the local thermo-electric electromotive forces. During both half cycles the difference in the current in the two upper arms flows from *h* through the galvanometer circuit to the point J or the reverse, thus producing a pulsating unidirectional current through this circuit, whose value depends on the heating effect of the main alternating current to be measured. By adjusting the point *J* along the resistance *W*, inequalities in the resultant electromotive forces in the arms are balanced. The current in the galvanometer circuit may be regarded as that set up by the thermocouples acting together and in this sense the points *h* and *J* are equipotential points for the alternating-current applied, just as they would be in a regular Wheatstone bridge. In the same way the points *e* and *f* may be regarded as equipotential points for the thermocouple circuit. But it should be noted that this arrangement of four arms is not a Wheatstone bridge and does not observe the laws of the latter. Strictly the points *e* and *f* are not at the same potential, nor are the points *h* and *J*. The conception of the whole arrangement as a rectifying means makes its action most clear.

VOLTAGE OF EDISON STORAGE BATTERY.—What is the voltage of the Edison storage battery?—H. M., Milwaukee, Wis.

The average discharge voltage of the new Edison storage battery is very close to 1.2 volts. To find the number of cells needed to give a certain voltage, divide this by 1.2. For further data and information on this battery see the article on "The 1910 Edison Storage Battery," on other pages of this issue.

New Electrical and Mechanical Apparatus and Appliances.

Electric Lighting of Automobiles.

In order to do away with the inconvenience of charging an automobile lighting battery from an external source of supply, the Hartman Electrical Manufacturing Company, Mansfield, O., has brought out an automatic lighting system which may be installed in any car. The apparatus consists of a six-volt generator driven from the engine shaft by belts, chain or direct-connected gear drive; a battery which floats on the line and supplies current when the car is at rest or the engine is running below generating speed; and a regulator, operating to maintain constant voltage at all engine speeds.

The generator shown in Fig. 1 is of the four-pole, closed, iron-clad type wih a field ring of special steel having a high permeability. The armature is built with closed slots with coils wound of a single large wire. Imported ball bearings are used, properly selected with reference to the work to be performed. At a speed of a little above twelve miles per hour, it will generate about nine amperes, or sufficient to supply all the current needed for head, side and tail lights and ignition. The maximum capacity of thirteen amperes is reached when the car is going at a speed of about fifteen miles per hour.

As the engine speed varies from one to 2,000 revolutions per minute and as the speed of the generator will be proportional, it is obvious that some means must be provided for governing the output of the generator and maintaining a constant voltage at the lamps and battery. This regulating device is contained in the iron box shown in Fig. 2, which contains also the terminal board, switches and fuses. Two relays are used, one for operating the main switch, which is placed between the generator and the battery, and the other for controlling the shunt-field circuit.

When the car is at rest or the generator is running below the speed necessary for charging, and for maintaining the lamps at proper voltage, the main switch remains open, thus cutting out the generator and preventing the battery from discharging through the generator armature. Whenever the engine attains a speed sufficient to drive the car at about twelve miles per hour, the generator picks up the load and the main switch is automatically closed. The lamps, if in use, are then carried by the generator and the surplus current is fed into the battery until it becomes fully charged. When the speed of the

FIG. 1.—FOUR-POLE GENERATOR.

generator increases the second relay comes into action and by means of an ingenious device weakens the current to the fields, causing the voltage to drop instantly to the proper value. The result is a practically constant voltage at the battery and lamps, the variation being less than one-fourth over a range of speed from 1,200 to 6,000 revolutions per minute. Ideal conditions for charging the battery are obtained, the current flow being greatest

FIG. 2.—REGULATING DEVICE.

when the battery is low and tapering off gradually as the battery becomes fully charged. As the generator voltage remains constant at a point below the maximum voltage of the battery on charge, there is no possibility of over-charging the battery. Whenever the engine speed falls below approximately ten miles per hour, the dynamo is automatically cut out, and the battery then carries the full load. As shown in Fig. 2, three switches are used for the head, side and tail lights. Sockets for plugging in a trouble lamp are also provided in the regulator box. A "turn-down" feature is provided in connection with the head lights by means of which these lights can be turned down about one-third. The system is entirely automatic and requires no attention other than the occasional oiling of generator bearings.

Electrically Operated Street-Railway Switches.

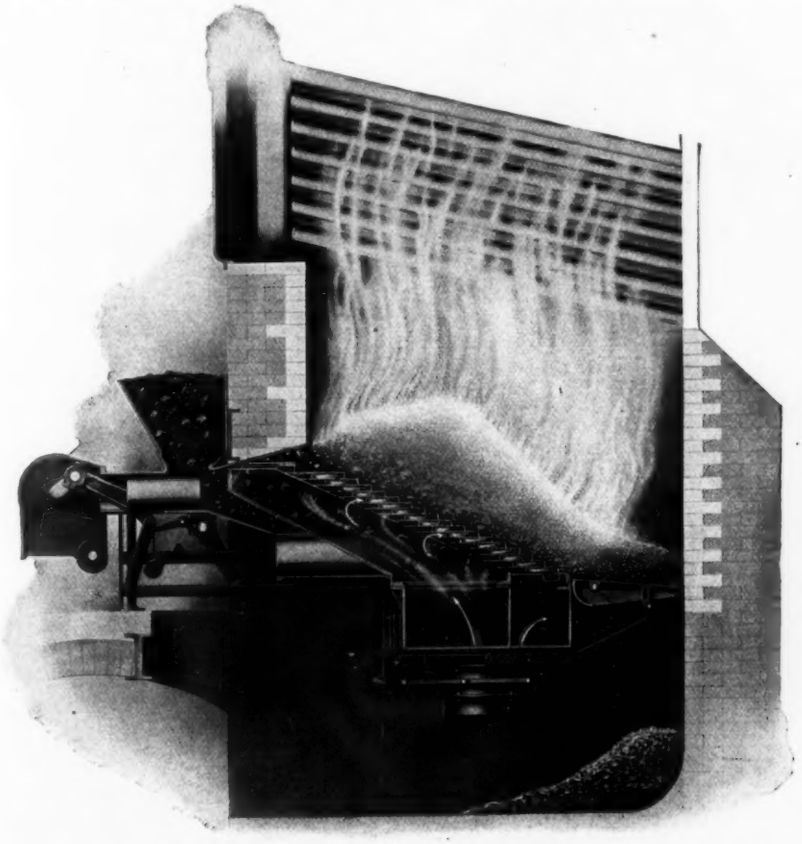
At the recent Tramways Congress at Brussels, says the London *Times*, much was said about an apparatus invented by a Liège engineer, M. Battaille, for working street-railway switches by electricity.

The device consists of two electromagnets placed in a cast-iron box close to the switch and controlling the switch rails, and of two commutators fixed to the trolley wires about fifteen yards from the points and about three or four meters apart. The first commutator encountered by the trolley or bow collector may be supposed to work the electromagnet which gives access to the right-hand road, and the second to work that which commands the left-hand road. In that case, if the car has to go to the right all the driver has to do is to take current as he passes the first commutator and to break the circuit under the second, and *vice versa* if it is necessary for the car to go to the left. Advantages claimed are that it is simple and strong; that it is worked instantaneously by the driver; that no special equipment is necessary on the cars; that it is worked at such a distance that the driver can see whether or not the switch has been properly thrown over; that the appliance can never remain "live," the circuit being closed only when the trolley is under the commutator; that there is no relay nor complication of circuit; that the arrangement does away with the stoppages of the cars which are otherwise necessary for the manipulation of the points, and effects a saving in that it is not necessary to have fixed pointsmen; and that the cost of maintenance is insignificant.

Improvement of the Taylor Stoker.

The Taylor stoker has been developed to dispose of the refuse so readily that coal can be burned in the large quantities necessary for operatng boilers at double their rated capacities. It makes possible the concentration of load on a few boilers and the minimizing of losses by maintaining intense fires and rapid circulation.

The difficulties encountered in the disposal of the large amounts of ash resulting from high rates of combustion have been overcome in the Taylor stoker by feeding the coal beneath the burning fuel, at an angle to the fire surface, so that gravity is utilized in carrying the burned-out coal to the dumping plates at the rear as well as in the distribution of the fuel.



TAYLOR STOKER—LONGITUDINAL SECTION THROUGH FIRE.

From the first the fundamental design of the Taylor has remained unchanged because of early recognition of the importance of ash removal; but improved mechanism has been necessary as larger and larger stokers have been called for. These changes relate principally to the operation of the lower line of plungers, which push the burned-out coal onto the dumping plates.

The travel, or length of stroke, of the upper row of rams which assist gravity by pushing the coal outward into the fire is constant, but the travel of the lower row can be increased to push the refuse out more rapidly just after the dumping plates have been dropped, or whenever it is desired to more quickly get rid of the refuse which has collected in the lower part of the furnace.

As previously built, each lower ram was connected directly to the bell crank which operated the upper plunger. Adjustment of the stroke of the lower plungers was made for each separate retort. With the improved mechanism, the travel of all the lower rams may be lengthened or shortened simultaneously. This is accomplished by means of a sort of pantograph lever connection having a cam and balance weight on the upper member as shown in the sectional view of the furnace. Pivoted to the plunger connecting rods these cams are connected by means of chains, lever arms and shaft to the operating handle at the center of the stoker. To alter the travel of the lower rams the adjusting lever is dropped, releasing the cams and permitting them to become horizontal, which action lengthens the stroke of the plunger. In case the vertical connection of the bell-crank lever is in such position that the cam cannot drop, it merely remains at rest until the connection moves backward and the counter-balance weight falls and carries the cam into position.

Another change which simplifies the operation of the stoker is the relocation of the speed-shaft sprocket. It is now placed at the end of the stoker with the clutch and face plates which hold the shearing pin on the outside. This greatly facilitates the replacing of the shearing pins when required and also the throwing of the stoker on or off the line. It also improves the connection to the fan shaft.

A third improvement is the alteration of the dumping plates. In early forms, the dumping plate was cast in one piece but the present design calls for a dumping plate in sections which are independently renewable, facilitating and lessening the cost of repairs. Improvements of minor importance but which, nevertheless, make for simplicity, more certain operation, and reduction of repair charges, are the use of lock nuts, the fitting of the crank shaft brackets to the ram boxes with body-bound bolts, and an increase in the size of the gears in the gear boxes and shafts and bearings. To insure more certain connection between the cast-iron ram boxes and the tuyere boxes they are now carefully doweled together.

Electrical Supply in Baltimore.

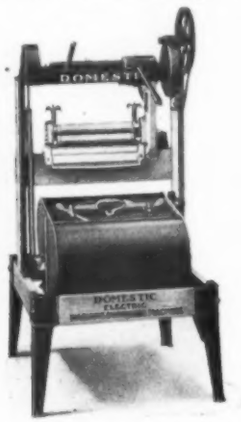
According to the *Engineering Record*, Robert J. McCuen, superintendent of the Department of Lamps and Lighting of the city of Baltimore, Md., has submitted to Mayor Mahool of that city a report on prices charged by the Consolidated Gas & Electric Company for gas and electricity supplied to the city. He recommends the establishment of a municipal electric plant for the purpose of serving the city street lamps and public buildings. He estimates the cost of such a plant, allowing for the value of the real estate, transmission lines and other equipment, at $909,050. He estimates that the maintenance cost, allowing for interest on the investment,

loss in taxes, depreciation, loss in municipal subway rentals, repairs, line transmission losses, insurance, labor, tools, supplies and the annual production of 6,470,779 kilowatt-hours at $247,606, and he estimates that the cost to the city per arc lamp per year for the street lighting would be $43.29, while current for the public buildings would be had at 1.9 cents per kilowatt-hour.

The Domestic Washing Machine.

An electric washing and wringing machine is being put upon the market by the Domestic Equipment Company, 1304 Masonic Temple, Chicago. This machine makes use of some of the latest ideas in washing machines and avoids the use of any mechanism inside the tub.

The tub is made of sheet copper and brass, and has an oscillating motion, its shape being shown by the accompanying illustration. It is entirely smooth inside and there is nothing to wear, tear or chafe the clothes. The wringer is of metal, with an open frame; it is easily controlled from the front, rear or side and is instantaneously reversible.



DOMESTIC ELECTRIC WASHER.

The gears, shaft and driving chain are entirely inclosed.

The motor is supported upon a bracket, which is bolted to the frame at but one point, and the weight of the motor acts in a way to keep the belt always tight. The motor is of Holtzer-Cabot make, of one-quarter horsepower. The frame of the machine is of wood and it is supported upon cast-iron legs. The machine is thirty-six inches long, thirty inches wide and fifty-eight inches high. It weighs 180 pounds. It is stated by the makers that it is especially fine for blankets and it easily handles heavy quilts, bed spreads and other heavy articles, as well as laces. For the usual tubful of articles, only seven minutes of operation is required.

New Speed Regulator for Small Motors.

That the use of electricity is becoming more general is evidenced by the increased use of small motors for operating devices of every kind. The small motor is now used in the household, office and shop. In some applications a

MOTOR SPEED REGULATOR.

means of varying the speed of motor is desirable and for this purpose the Cutler-Hammer Manufacturing Company, Milwaukee, has designed and placed on the market a line of small six-inch speed regulators. These devices are made in standard capacities from one-twentieth to one-sixth horsepower.

They are adapted for many purposes, such as varying the speed of motors operating small blowers, buffers, sewing machines, washing machines, jewelers and dentists' lathes and drills, coffee mills, adding and copying machines, etc. They are also used as dimmers for lighting circuits up to their capacities, as small field regulators, in connection with plating lathes and for controlling heating circuits, such as tire vulcanizers, etc.

The operation is by means of a simple sliding lever. Seven contacts are provided giving seven running positions, or these contacts can be arranged to provide one "off" point and six running positions. The resistance is moisture-proof and dust-proof, the resister wire being wound on a porcelain core and imbedded in a special cement which encloses all portions. The shape of the unit is flat and is secured directly to the casting. The diameter of this regulator is six inches, the depth of casting one and five-eighths inches and the net weight two and one-half pounds, making a compact, convenient device.

The "Cozy" Electric Toaster.

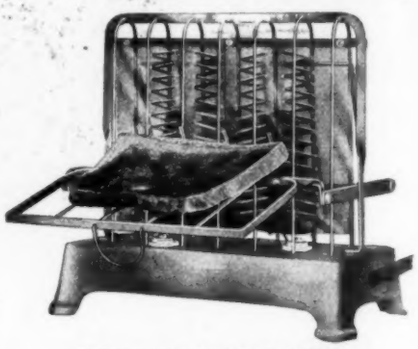
The usefulness and convenience of the electric toaster has created for it a permanent place in practically every household where electric current is available. To meet the varied demands for toasters which occurred shortly after their introduction they have been manufactured in a variety of styles and sizes to meet every requirement.

A toaster which is being favorably received, owing to the commendable features it embodies, is shown in the accompanying illustration. It is known as the "Cozy" and is a two-sided upright toaster. The base is plain porcelain, clean and sanitary. The frame is heavy white nickel plate. There are no soldered or welded joints to become loose or unfastened.

The heating element is of a special composition, which the manufacturers claim insures even distribution of heat and great endurance. The heat therefrom is said to toast a slice of bread in forty-five seconds.

A special feature of the toaster is the frame which holds the bread. This is so arranged that when it is necessary to turn the bread it may be easily lowered. The toaster holds four slices of bread. It is furnished with lamp cord and attachment plug which will fit any lamp socket.

The "Cozy" electric toaster is being



"COZY" ELECTRIC TOASTER.

manufactured and placed on the market by the Phelps Manufacturing Company, Detroit, Mich.

Research Laboratory for American Rolling Mill Company.

To aid in its chemical and electrical development work, the American Rolling Mill Company, Middletown, Ohio, has equipped a $40,000 research laboratory in which the most modern apparatus available for this purpose has been installed.

An Interrupter for Railroad Telephone Work.

A new interrupter, designed especially for railway telephone service, has just been placed on the market by the Western Electric Company. This interrupter, known as the 62-A, is especially adapted for use in block towers, where the operators are so busy that they do not have the time to call other stations by means of a hand generator. It is also especially well adapted for use on yard lines where several telephones are connected to the same pair of wires. It is not limited, however, to this class of work, but is very efficient in all code ringing work, as the signals, due to the sensitive mechanism, can be made very clear and distinct.

The No. 62-A interrupter, a closed view of which is shown in Fig. 1, is

FIG. 1.—INTERRUPTER FOR RAILROAD TELEPHONE WORK.

intended to be mounted normally upon the wall in a vertical position in the same manner as a telephone set. The set is enclosed in a neat, well-constructed oak cabinet, provided with a hinged cover. This cover is provided with a glass window, through which the operation of the mechanism can be observed when the cover is closed. The mechanism is mounted upon the base of the cabinet and is readily accessible for adjustment, test and inspection.

The interrupter is operated by means of a key, or push button, which closes a battery circuit containing four to eight dry cells. The number of cells necessary depends upon the number of bells it is desired to ring. It is recommended that five dry cells be used, which will efficiently ring fourteen 1,000-ohm ringers, or sixteen 2,500-ohm ringers on a line of 500-ohm resistance, an equivalent of about a thirty-mile metallic circuit of No. 12 B & S copper wire.

The interrupter is so adjusted that it

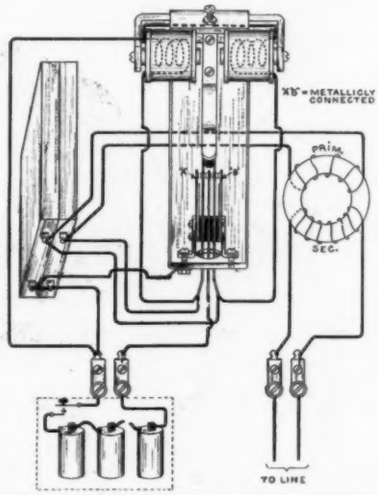


FIG. 2.—DIAGRAM OF INTERRUPTER.

responds at once when the key is pressed, closing the battery circuit. This insures a very economical current consumption, as the interrupter is only in action when the battery circuit is closed. The mechanism is practically noiseless and sparkless. All circuit contacts are of platinum. While the mechanism is very sensitive, it is built

FIG. 2.—FEDERAL 500-WATT TUNGSTEN UNIT.

in a substantial manner which insures long service and low maintenance.

The circuit diagram shown in Fig. 2 shows the simplicity of the circuit and the ease with which it can be connected.

New Tungsten Units.

The new 250 and 500-watt tungsten-filament lamps are among the latest developments of high-candlepower lighting units. In steady brilliancy of illumination and economy of current consumption they are unique and are being used extensively where large areas, both interior and exterior, are to be illuminated.

The fixtures shown in the accompanying illustrations are designed to produce the same efficiency of illumination that has been attained in the use of smaller candlepower tungsten fixtures.

The unit shown in Fig. 1, designed for 500-watt tungsten lamps, has a

FIG. 1.—FEDERAL 500-WATT TUNGSTEN UNIT EQUIPPED WITH GLASS SHADE.

twenty-inch glass bowl shade with a ten-inch opening and spun-brass dome 10.5 inches in diameter. It has a six-inch white porcelain enameled-steel disk, wired, with large base socket.

The unit shown in Fig. 2 is also designed for 500-watt tungsten lamps. This unit has a twenty-inch black-porcelain enameled-steel shade and spun-porcelain enameled-steel dome seven inches in diameter and five inches high. It is equipped with an eighteen-inch stem of iron pipe one and one-eighth inches in diameter, painted black, with ornamental cast-iron ceiling base, and is also equipped with a large-base socket. It is furnished wired.

These units are being manufactured and placed on the market by the Federal Electric Company, Chicago, Ill.

Electrical Business Good.

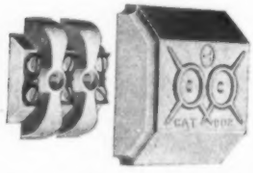
During the current year, the General Electric and the Westinghouse Electric & Manufacturing Companies have both experienced prosperity. With the exceptions of July and August, the new business received has been better than in almost any previous year.

Trumbull Splicing Blocks.

In the accompanying illustrations are shown two and three-wire splicing blocks which the Trumbull Electric Manufacturing Company is placing on the market to complete its line of molding branch blocks.

These splicing blocks are for straight-away work where splicing was formerly necessary. The Fire Underwriters allow no joints or taps in molding unless protected by fittings. These blocks, the manufacturer states, meets all requirements.

TWO-WIRE SPLICING BLOCK.



THREE-WIRE SPLICING BLOCK.

New Three-Wire Generators.

A new design of three-wire generators is being placed on the market by the Triumph Electric Company, Cincinnati, O. Heretofore the chief objection to three-wire machines has been the poor commutation on unbalanced loads. The Triumph Company claims to have entirely eliminated this fault, and has perfected a machine that is absolutely sparkless on unbalanced load, as well as on balanced loads. This is such an important feature that the success of these machines is practically assured—the Triumph Company also states that a good number of these machines have already been sold, and orders are now in the shops for many more.

These generators are built as belted units, or for direct connection to any standard engine with which they form an exceedingly compact unit. They are being successfully employed for light and power distribution in areas not exceeding one or two miles, and are particularly suitable for furnishing light and power to large stores, office buildings, etc., and for general use in manufacturing establishments.

The two-voltage feature of three-wire distribution is particularly advantageous for buildings or shops where variable speed motors are in use. With field control a wide range of speed can be obtained on account of the flexibility of the system, and at the same time the saving in copper is quite a considerable item.

These generators permit of parallel operation, and may also be operated in connection with two-wire machines when so desired.

Standard machines are designed to take care of an unbalanced load of twenty-five per cent; other capacities can be obtained, however, when so desired. The balancing coils or transformer supplied with these generators consists of three interconnected windings upon laminated iron cores, and is suitably mounted in a cast-iron case.

VIEW OF ARMATURE.

TRIUMPH THREE-WIRE GENERATOR.

These machines are built in all standard sizes from twenty-five kilowatts up, and are wound for 250 volts, so that 125 volts can be obtained from either side of the three-wire system. The accompanying illustrations show the general design and appearance of these units.

Current Electrical News

GREAT BRITAIN.

(Special Correspondence.)

LONDON, NOVEMBER 18.—Considerable light is being thrown upon the failure of the Griffiths-Bedell surface-contact system of electric traction with which the London County Council experimented in 1908, by a libel action now being heard against Sir John Benn, a leading figure in metropolitan political circles. This gentleman in public speeches has referred to the Griffiths-Bedell system as an inefficient one, and as a mischievous and impossible system. Consequently the owners are going into great detail in court in order to demonstrate that the system which failed in London was not their system, but a caricature of it designed by the officials of the London County Council. It is alleged that the whole principle of having a gas and air-tight conduit to carry the cable was violated; that the blower used for ventilating purposes was absent and that but for a frantic appeal by the patentees the system would have been started, after an accumulation of gas for several months, without any ventilation whatever. In the end, the aid of vacuum cleaners were requisitioned. The types of access box and sump pit were neither air, water or gas-tight, a serious defect in a fundamental feature of the system. It is also stated that salt was put upon the track—and nowhere else—without the slightest need from weather conditions, and that the majority of live studs due to surface leakage were attributable to this cause. The magnetic equipment underneath the cars is also said to have been entirely remodeled with disastrous results.

It is stated that the London Electrobus Company is to be reconstructed and buses again placed upon the London streets. This is interesting in view of recent statements that another company is being formed to place electrically-driven buses in London.

In an endeavor to arrive at a compromise with regard to the proposal that all municipalities in the kingdom should have powers to wire premises for electric light, a conference was held last week between members representing the societies on either side. It is officially announced that the preliminary arguments were regarded as so satisfactory that a further meeting is to be held.

The Leeds Corporation have ordered a number of vehicles for their railless electric traction scheme.

Sir Oliver Lodge has made the suggestion that a sum of $500,000 annually should be allotted by Government to universities for experiments in the dispersal of fogs. He proposes to deal first with seaports, which he regards as particularly suitable for treatment by electrical means.

The possibilities of electrical energy at one-quarter of a cent per unit, suggested in Mr. Ferranti's presidential address to the Institution of Electrical Engineers, has naturally attracted considerable attention. Mr. Ferranti foresaw the erection of one hundred generating stations, each of 250,000-kilowatt capacity, and in view of the manner in which Mr. Ferranti in the past has been so truly ahead of what actually happened, there is little disposition to be cynical at the suggestions now made. G.

CONTINENTAL EUROPE.

(Special Correspondence.)

PARIS, NOVEMBER 17.—The present electric plant of Rouen, France, is to be considerably enlarged so as to distribute current on a large scale for the city as well as for the outlying districts, including a number of communes. The project is being carried out by the Paris Electrical Energy Company in connection with the Zürich electrical bank. At Macon, the Gas Company is preparing to erect an electric lighting plant for public and private lighting. The Light and Electric Company has applied for the rights for a lighting station in the town of St. Romain. The contract for the Mont Dore electric station will soon expire, and it is likely that it will change hands. At Chateau-Thierry the Municipal Council is considering a project for lighting the town which has been brought before it by the Vauthier Company, which now controls the gas lighting.

Tests have been made with the use of a ground return upon the power line running from the St. Maurice hydraulic plant to Lausanne. During the last year the plant has been thus operated and the result is very good. It will be remembered that the line is worked on the Thury direct-current system at high voltage, using machines in series. The voltage used at the turbine station, which lies on the Rhone, near Lake Leman, is now 20,000 volts. In view of the good results obtained by the use of the ground return, it is likely that this method will be continued in the future. There is found to be no disturbance to telephone lines.

The Heroult-Lindenburg electric-furnace process for steel manufacture is being taken up in Russia, and it will be used in two different metallurgical plants, these being the Sormovo Company, near Mijni-Novgorod, and the Russian blast furnaces at Makievka, in the Donetz region.

Producer-gas motors are now running in the new plant erected at Mont-sur-Marchienne, near Charleroi, Belgium. There are two groups of 100 horsepower each now installed which generate direct current at 500 volts. The motors are of the horizontal type and are supplied by boilers of the Bollinckx type, constructed in Belgium.

In Austria there will be run an electric traction line from the town of Smichow to Malzavinka. At Landeck, in the Tyrol, a hydraulic plant will be erected at Faggenbach, according to the present plans, and it will furnish about 30,000 horsepower. Part of the current will be used for the new Vintschgau electric railroad. I also note the project which the railroad administration is considering for a turbine plant, which will be fed from the Fuschl and Mond lakes and will have a 180 meter fall. A flume will bring the water to the locality of Fuschl and it is probable that the station will be located at St. Lorenz.

Electric cranes are to be used extensively at the port of Marseilles, and five of these have been lately ordered from a French company.

For operating one of the sections of electric railroad in Sweden, the Government railroad department is to erect a large turbine plant at Torju. The contract has been awarded to the Swenska Company and the Siemens-Schuckert firm.

The French battleships *Justice* and *Verite* are to proceed to the Algerian coast in order to make tests of the new wireless telegraph and telephone apparatus which has been installed upon them. Experiments will be made between the Algerian and Tunisian coasts, Corsica and France, and the tests upon the new wireless telephone system will be of special interest. By means of a variable series of standard notes for the arc vibrations it is expected to secure a good tuning of the instruments so as to insure secret working.

An electric railroad is to be built in order to connect Vienna with Pressburg-Poszony, and the matter is taking active shape at present, as the engineers are at work upon the plans for the traject and the different stations. We also note the electric line which is to run from the railroad station of Misslitz to the town.

In Russia there will be built an electric railroad from St. Petersburg to Imatra in connection with a local power network, using the falls of the Imatra stream for this purpose. Current will be used at St. Petersburg from this plant.

The tramway company of Kier is increasing its rolling stock and has placed an order for twenty new outfits with a French electrical firm.

The municipal council of Cabourg, France, is making arrangements to receive current over a power line from the Caen electric plant. The current will be used also in a number of other watering places on the Channel coast, such as Dives and Houlgate. An electric tramway will be built at Cap Vern, in the Pyrenees region, in order to connect the railroad station with the town. Plans for electric lighting are being drawn up in the towns of Neulize and Vatan, France. At Nice, the port will be lighted by arc lamps, according to a recent decision. A. DE C.

CANADA.

(Special Correspondence.)

OTTAWA, ONT., NOVEMBER 26.—A preliminary survey of the proposed electric railroad, to run from Ottawa to the city of Kingston, Ont., has been made. As soon as the charter is secured, work on the new project will be rushed.

Dr. Haanel, director of mines, has just returned to Ottawa from Nelson, B. C., where he inspected an electric smelting plant for the treatment of complex zinc-sulphide ores. This is a problem of much importance to Canada, and the government has appropriated $50,000 to be used in the investigation of the subject.

The electric light company of London, Ont., which has been so far unable to come to terms with that city relative to the disposal of its plant, has appealed to the Ontario Government to interfere with the view of preventing duplication, and to determination of a price as a basis of sale. The City has already proceeded to a considerable extent with installation of its distribution system.

At the fifth annual convention of the Canadian Independent Telephone Association, held in Toronto, the president said that five years ago there were scarcely any independent telephone companies in Canada, but now there were more than five hundred of such companies. Southern Ontario was being rapidly covered by a network of independent lines; independent companies were extending in Northern Ontario and, generally speaking, the building of a few connecting lines would complete a great system of independent lines throughout the province.

A novel system of telephone protection of timber limits is being adopted in Quebec province by the River Ouelle Pulp & Lumber Company. Some fifty-two miles of telephone line have been strung, forming a circular chain of communication in the heart of the Company's limits. Telephones have been installed for the use of the fire rangers at many points along this line, and portable telephones which may be adjusted to the line at any point, are to be supplied the rangers. By this means a ranger can notify headquarters in a minute of time, and have other rangers come to his assistance. It is expected that this system will be adopted by most of the limit holders, and probably by the provincial government for the safety of the Crown timber lands, especially where they are traversed by railways.

That the new gold mining camp at Porcupine, in Northern Ontario, is not being neglected in the matter of electric power for driving the many plants about to be installed in the mines there, is made apparent by the fact that the Porcupine Power Company expects to be in a position to deliver electric energy by June next. The power plant is to be installed at Sandy Falls, on the Mattagami River. The plans, specifications and surveys have been completed, and contracts let for generators, switchboards and water wheels. The turbines will be supplied by the Morgan Smith Company, of York, Penn. It is proposed to install two units in the first place, which will be about 3,000 horsepower. The current will be alternating, three-phase, twenty-five cycles, and the transmission-line voltage to the consumer will be 12,000 volts.

MEXICO.

(Special Correspondence.)

MEXICO CITY, MEX.—The National Congress has passed a bill authorizing the Mexico Tramways Company to construct two important lines of electric railway. One of the proposed roads is to run between this city and Puebla and the other between here and Toluca. The Puebla line will be about 125 miles long and the Toluca line about forty-five miles long. The Mexico Tramways Company is a subsidiary of the Mexican Light & Power Company, the Canadian concern which has installed a great hydroelectric plant at Necaxa and constructed a system of electric transmission lines radiating to this city and various other towns and industrial centers within a radius of 150 miles. The preliminary surveys for the proposed electric railways have been made. The line between this city and Puebla will pass through the mountains close to the Popocatepetl and Ixtaccihuatl volcanoes. There are a number of important towns and popular resorts along the routes of the proposed roads.

The construction of these two railways, which will begin soon, will mark the inauguration of a new era in electric railway building in this country. The Mexico Tramways Company already has a number of lines running from this city to suburban towns.

E. Schondube of Mexico City has been granted a concession by the government of the state of Durango for the installation of a large hydroelectric plant and the construction of a system of transmission lines around Guanacevi. The proposed plant will be located near Guanacevi and the electric current will be conveyed to this mining district and to the districts of El Oro, Tepehuanes and Inde. The concession requires that Mr. Schondube shall furnish to the Government for such use as it may require light and power for the period of five years, free of charge, and after that time it is to be furnished at fifty per cent less than to other consumers.

The Compania de Madera de la Sierra, which operates lumber mills near Llano Grande, Durango, will install a hydroelectric plant in the San Vicente district.

One of the largest electric signs in the world will be erected on the housetops near the corner of San Juan de Letran Street and Avenida San Francisco in Mexico City. It was designed by H. R. Ross of New York, and will be sixty feet long by thirty feet wide, supported on massive pillars twenty-five feet above the roofs. Above the top of the sign, again, these pillars will continue, to terminate in huge electric torches. Directly above the sign, and also borne by the two pillars, will be 1,800 feet of advertising space. D.

COMMISSION NEWS FROM NEW JERSEY.

(Special Correspondence.)

The Board of Public Utility Commissioners has published its findings and a recommendation made following receipt of a complaint that the New York Central and Hudson River Railroad Company, lessees of the West Shore Railroad Company, does not provide a proper system of ventilation at its Weehawken tunnel. The Board finds that the complaint is justified. The Railroad Company at a hearing of the complaint advised the Board that it was then engaged in an investigation of the subject of meeting the conditions at this tunnel, through a system of mechanical ventilation. Later a description of the ventilating apparatus proposed to be installed was submitted to the Board. This was described as consisting of two electrically-driven fans capable of delivering 500,000 cubic feet of air per minute through a nozzle approximately sixty feet long. The inner surface of this nozzle conforms to the tunnel section and the outer surface of it is funnel shaped, decreasing in size from the fan to the tunnel opening. The apparatus is so arranged as to deliver the above quantity of air in a stream around the sides and top of the tunnel opening, and the center of gravity of the air blasts is to coincide with the center of gravity of the tunnel section. The location of the apparatus is to be outside the New Durham portal and the electric current is to be furnished by the Weehawken power-house. Extra transmission apparatus to be installed in two units so as to provide against accident to either unit. The present shaft to be closed in order to make the ventilation system effective.

The aim of the new system is to so dilute and remove any combustion gases and vapors as to render them inocuous.

The Board after an examination and favorable report by its engineers has approved the plan, and has recommended that the Company proceed to install the system in its Weehawken tunnel.

COMMISSION NEWS FROM NEW YORK.

(Special Correspondence.)

The Public Service Commission, Second District, has authorized the Livingston-Niagara Power Company to exercise franchises in the towns of Avon, Caledonia, Geneseo, Lima and York, and in the village of Caledonia in the county of Livingston, and in the towns of Mendon, Rush and Wheatland in the county of Monroe. The Company proposes to distribute Niagara electric power through the territory in which it has obtained franchises.

The Commission has consented to the transfer by William Stock of certain property, rights and franchises to the Hannibal Electric Company, also of a franchise held by him in the towns of Granby and Hannibal and the village of Hannibal, Oswego County. The Hannibal Electric Company is permitted to sell, transfer and assign its franchises in the towns of Granby and Hannibal and the village of Hannibal to the Oswego River Power Transmission Company.

The Commission has authorized the Islip Electric Light Company to issue $30,000 capital stock and bonds to the amount of $20,000. The proceeds are to be used for the improvement and extension of the plant of the Company at Islip, Long Island.

Frank J. Sprague, the well known consulting electrical and civil engineer, has sent a communication to the Public Service Commission of the First District, State of New York, suggesting in the case of the New York subway situation (1) a compromise plan of subway extensions on the basis of city participation in all net profits after certain deductions, and (2) an alternative plan for independent lines, on which he is willing to guarantee a bid for operation, with the city sharing in both management and profits. The first part of this communication includes a letter to Theodore P. Shonts, president of the Interborough Rapid Transit Company. Mr. Sprague holds the view that rapid transit development should proceed on the basis of a consistent, unchanging and effective policy of co-operation between the City and the present or future possessors of franchises acquired in a legal and proper manner, with city participation in all surplus profits. Mr. Sprague continues:

"On one hand is a great municipality, represented by the Public Service Commission and the Board of Estimate and Apportionment, with constructive rights of franchise over every unoccupied street within its limits, the power to grant valuable elevated privileges and extensions, absolute title to a property costing nearly $63,000,000 and operative possession after a period of years, an administrative power to determine the character and frequency of service on existing roads, and a present basic available capital of $60,000,000, with regular annual increase obtainable on interest terms denied to any private corporation.

"On the other, is a private operative company with two profitable leases; one, of an old established elevated system built with private capital, and with practically unlimited franchise, and the other a limited but profitable contract with a city owned system, and with $31,000,000 invested in an operative equipment, practically useless at the end of its lease unless taken over by the City, and which the City at that time has the right to take over on reasonable terms.

"Herein lies the basis of an absolutely equitable agreement which will properly protect every financial investment, and be of immeasurable value to the City of New York.

"If an independent banking and traction syndicate resolutely opposed to your traction interests, and familiar with the possibilities of transportation problems and the practical means of compelling working agreements, were possessed of the great powers of the city authorities, there would be shortly effected a mutual understanding which would insure, under joint direction, the most rapid development of transit facilities to meet all reasonable demands, and the maximum efficiency and profit in operation, or else the establishment of an independent self supporting system of adequate compelling character.

"According to your annual report for 1909-1910, the Interborough Company made certain suggestions for extensions of its lines with funds supplied by the City, the latter to participate in the earnings accruing from such additions only. This, although at least debatable, for it adopted the principle of a division of profits, was, seemingly, rejected.

"A share of profits on extensions can be translated into a percentage of profits of the whole on some equitable basis which recognizes all the contributing features, and as matters now stand, both the Interborough Company and the Public Service Commission may well consider a material expansion of the earlier proposition

on a new basis, namely, that the City shall share to a proper degree in the profits from all subway operation, and to a lesser degree in all elevated profits as well, on condition of a voice in the Company's management and the adoption of a fixed policy of co-operation during the life time of the present franchise.

"The essentials of such an agreement could be as follows:

"1. Abandonment of projects for competing subways, and the progressive expansion of the present system as a nucleus, under the guidance of an engineering board representing the Public Service Commission, the City of New York and the Interborough interests.

"2. Extensions to be with city funds, to be constructed in sections under competitive bidding, with premium and time forfeitures, and to be put into operation as fast as completed.

"3. All operative equipment to be provided from private sources.

"4. In addition to maintenance, an obsolescent and sinking fund to be established against the time of termination of the operative lease, at which termination a balance should be struck depending upon the difference between the sum of the then determined value of the equipment, plus the capital and accrued interest of the obsolescent fund, and the capital invested in equipment at cost.

"5. Interest and sinking fund on extensions to begin at a definite period after commencing operation, and the bonds so issued, as all present outstanding subway bonds, to be a first lien on the entire Subway.

"6. The private capital already invested to be entitled from the excess net earnings to a profit equal to that which it now enjoys, and the additional investment necessary for increase of equipment to have a reasonable return.

"7. The balance of operating profits, since the existing and future extensions of the subway will be mutually dependent and contributary, to be shared on a basis of gradually increasing participation by the city as determined by a number of elements, among which should be the increased mileage, relative density of traffic and operating cost per passenger.

"8. Finally, suitable representation of the City on the Board of Directors.

"The elevated system could be treated on a similar basis.

"This general plan, if it could be established, would form a basis for the most rapid, satisfactory and economical advance conceivable.

"On its part, the Public Service Commission can well endorse this plan, even if it does mean the abandonment of its present project, for it would insure that for which, in a large measure, it was created.

"On the other hand, the Interborough can acquiesce because of the removal of the threat of competition and of the necessity of raising funds for private construction, the elimination of the constant friction between itself and the Commission, the assurance of maintenance of earnings and a probable increase in the stability and value of its securities."

The above is made as a general suggestion in the hope that it may be found to contain the essentials of a fair settlement of public and private interests. Further Mr. Sprague says:

"If, however, the Interborough interests will not definitely renew their offer to meet the city authorities on some general basis of extensions with a fair participation of profits, then let the Public Service Commission, as I have already pointed out, do what any competent private corporation would do—instead of attempting construction of a partly competing route on extravagant plans, made still more so to the extent of nearly $30,000,000 in the hope of getting a foreign railroad corporation to assume the burden not alone of the system but the added increase of cost—seize upon every strategic route sought by the Interborough interests which can be molded into a coherent workable system, construct it on sane lines at the minimum cost, so that it will atract and would maintain profitable independent operation, and when such is established compel joint operation, a reasonable voice in management and a fair division of profits."

Mr. Sprague then described what in his mind would constitute a logical development of the present system of subway. This, he believes, would command the support of independent equipment and operation, and the operative contract should be so drawn that the restrictive powers held by the Public Service Commission and the Board of Estimate on all the extensions of other lines controlled by the Interborough interests, it would insure with absolute certainty an ultimate amalgamation of rapid transit routes into a harmonious whole operated with due regard to the rights of private capital, but also with equal regard of public capital and vested rights.

In conclusion Mr. Sprague announces:

"So convinced am I of the soundness of this proposal from an operative standpoint, that if some general plan of rapid transit development with the present system as a nucleus cannot be agreed upon on the broad lines suggested, and it becomes necessary to build the competing line described, I am prepared, if such construction is undertaken on sound engineering plans, to put up a certified check of material amount as a guarantee that within sixty days of the receipt of acceptable bids for construction, I will bid, independently of the Interborough interests, for the operation of this proposed line on a basis of city participation in management and profits, and an offer of exchange of passengers with the existing subway system on an equitable basis."

Last week Mayor Gaynor issued a statement declaring his belief that New York City is unable to raise enough money to construct the projected $100,000,000 tri-borough system of subways. At the same time Samuel Rea, second vice-president of the Pennsylvania Railway, attacked the Hudson & Manhattan companies' proposal for operating the tri-borough system. Mayor Gaynor raised the question of the City's financial ability to construct such an elaborate system as the projected tri-borough route, and said the whole problem would be solved if some company would provide all the funds needed in excess of the $57,000,000 the city has in reserve for this purpose.

LIGHTING AND POWER.

(Special Correspondence.)

HIGHMORE, S. D.—T. J. Wixon and others propose to install an electric light plant at this point. P.

ANSLEY, NEB.—Bonds for $5,000 for the installation of a municipal electric light plant have been voted. C.

MOSINEE, WIS.—The Mosinee Electric Company has been incorporated with a capital stock of $15,000. P.

EGAN, S. D.—It is proposed to take a vote on issuing bonds for the installation of an electric lighting plant. C.

SEWARD, NEB.—The Blue River Power Company has been incorporated with a capital stock of $100,000. P.

LOS ANGELES, CAL.—Electric street lights to cost $2,000 are to be installed in the Cahuenga district, recently annexed. A.

MINNESOTA, MINN.—A franchise has been granted by the Village Council for the installation of an electric light plant. C.

SAN BERNARDINO, CAL.—This city is to have a municipal electric lighting plant. Work will commence on it early next year.

PAXTON, ILL.—The Paxton Electric Company will install a new 150-horsepower boiler, supplementing the one installed last summer.

LONG PRAIRIE, MINN.—A boiler explosion at the light plant caused a damage of $1,500. The installation of a new plant to run day as well as night is being urged by business men. C.

MELLEN, WIS.—The Peoples Water, Light & Power Company has been incorporated with a capital of $50,000. The incorporators are Robt. Johnson and others.

EASTON, ILL.—F. H. Conroy and Roy Holly will establish an electric light plant here and will ask the village board for a franchise to erect poles in the streets. Z.

ROYSE CITY, TEX.—The City Mill & Light Company has been incorporated with a capital of $12,000. The incorporators are J. N. Miller, E. M. Paulk, J. D. Miller and W. H. Adams.

BRAINERD, MINN.—The contract for the installation of an electric light plant has been let to the Toltz Engineering Company, of St. Paul, Minn., which will install a gas producer plant. C.

WATERTOWN, S. D.—This place is to be lighted with clusters of electric lights installed throughout the business and residential sections. Thirty-five of the clusters are to be in the business section.

NORTHFIELD, MASS.—The contract for supplying current for lighting the city has been awarded to the Greenfield Electric Light & Power Company. Current will be supplied to the city in a few weeks.

HANFORD, WASH.—The Pacific Light & Power Company, which has purchased the Hanford Irrigation & Power Company, will enlarge the plant at Priest Rapids and build transmission lines down the river. C.

EUREKA, S. D.—A franchise has been granted to G. A. McOaughlin, of Aberdeen, S. D., for the installation of an electric light plant, to be completed by March 1. Construction work will be started at once. C.

VICTORIA, TEX.—The Victoria Manufacturing Company has finished the installation of its new electric light plant. The lighting system consists of 150 sixty-candlepower tungsten lamps and seven arc lights. D.

CHILLICOTHE, ILL.—The Economy Light & Power Company of Joliet is making negotiations with local men to supply power for the pumping stations in the Partridge and Hennepin Levee and Drainage Districts. Z.

COUDERAY, WIS.—The Arpin Lumber Company is just finishing the concrete work on a dam which it is erecting across the Chippewa river, six miles from here. The flume of this dam will also be completed in a short time. M.

AUSTIN, TEX.—W. C. Day of Austin, state superintendent of public buildings and grounds, will recommend to the legislature that an appropriation of $10,000 be made for purchasing new machinery for the state's electric power plant. D.

ST. CHARLES, ILL.—The Business Men's Association has awarded to the McFell Electric Company of Chicago the contract to install upon Main Street fifty-four ornamental lamp posts, each bearing three sixty-kilowatt tungsten lamps. Z.

ELDORA, IOWA.—The Park Dam Power Company of Eldora has purchased the dam at Steamboat Rock. This will supplement the big concrete dam now being erected here in controlling the water supply for power generating purposes. Z.

INDIANAPOLIS, IND.—A committee headed by William A. Lytle, of Worcester, Mass., is visiting this city, Mishawaka and other cities for the purpose of obtaining ideas as to the lighting systems—especially the cluster system of lamps. S.

CARROLLTON, ILL.—Dr. R. H. Bigger and F. M. Sinsabaugh have disposed of their interests in the Carrollton Heat, Light & Power Company and it is said a company is in process of formation to take over the property, local capital retaining control. Z.

BELLINGHAM, WASH.—A new power house located near the central part of Bellingham, has just been completed, and fully equipped by the Whatcom Railway and Light Company and is to be used for the street-car service and lighting system of the city.

PINE RIVER, MINN.—The Power Engineering Company, of Minneapolis, Minn., has designed a power plant for Webber & Hill consisting of concrete dam, bridge, flume, waste ways and power house, and is supervising the construction and furnishing all of the equipment. C.

BELLINGHAM, WASH.—An electric elevator is to be installed in the new addition to St. Joseph's Hospital, in this city at a cost of $2,000. A number of citizens donated half of this amount, the other half being promised by E. B. Deming, head of the Pacific American Fisheries.

COLUSA, CAL.—C. F. Downing, William Whales and Mr. Steel, officials of the Pacific Gas and Electric Company, have arranged to commence work on a new power line here. The new line will carry a voltage of 15,000 and on its completion the old line from Gridley will be abandoned.

PORTOLA, CAL.—W. J. Crawford, I. G. Lane and Charles T. Tyre have located 40,000 inches of water on Grizzly Creek, about three miles above this place, and are planning to erect a power plant. It is expected that a small plant will be erected and the town supplied with power by Christmas.

CHATHAM, N. Y.—This village now has an electric power circuit operated by the Chatham Electric Light Company. Steam and gasoline power are being supplanted. The Chatham Grain Company is now operating its mill with a thirty-five-horsepower electric motor and is grinding 1,000 bushels of corn a day.

LEESBURG, IND.—Capitalized at $20,000 the Leesburg Light and Water Company has incorporated to build, equip, maintain and operate an electric light and water works plant. The Company will soon be in the market for material and equipment for the new plants. Frank Bartz, W. H. Stanley, Will Kohler and H. E. Kinsey are directors. S

ALTON, ILL.—Merchants on Third Street between State Street and Piasa Street, plan ornamental standards each bearing a cluster of three lights, to be placed at intervals of twenty-five feet on each side of that portion of the thoroughfare. President Hartmann of the Retail Merchants Association has appointed a committee to take up the matter. Z.

SPOKANE, WASH.—The National Power Company of this city with offices in the Columbia Building announces that it will thoroughly remodel its plant at Dishman, a few miles east of here. Several new buildings are to be constructed and machinery, to the extent of $40,000 will be installed. The work is expected to begin early next year. A.

MONTGOMERY, ALA.—Papers have been filed in the Secretary of State's office reporting the incorporation of the Marion Electric Company, of Marion, Perry County. The new company is capitalized at $10,000, of which amount $8,200 has been paid in. The incorporators are: T. J. Krouse, Emma L. Krouse, R. K. Lee, R. L. Ellis, Hugh Mallory and Paul Lovelace. I.

TOLEDO, O.—The Maumee Valley Electric Company, which was some time ago refused admission into Toledo, has secured entrance to the heart of the city through an unexpected source. The Company has secured permission from the State to erect its poles and wires on the banks of the Miami & Erie Canal. The poles have been placed and the wires are about strung, and it is said the plant will be in operation in a very short time. H.

PROVIDENCE, R. I.—The Narragansett Electric Lighting Company has completed a 175-foot tunnel from its station on South Street into the Providence River, by the use of which the present capacity of the plant will be doubled. The purpose of the tunnel is to secure water which may be used for the low-pressure engines. The dimensions of the tunnel are given as 175 feet in length, six and one-half feet in diameter, with an average depth of twenty-four feet under the surface of the water.

MATTOON, ILL.—Contract for the erection of a power plant station has been let by the Big Four Railroad Company to the Murphy Construction Company of St. Louis, which will do the brick and cement work. The machinery in the present plant will be supplemented by enough to enable the Company to furnish its own light, power and heat for all departments of the extensive operating headquarters here. Individual motors for machines in the repair shops are considered. Z.

ELECTRIC RAILWAYS.

(Special Correspondence.)

MADISON, WIS.— The Johnson-Main Street line of the Southern Wisconsin Railway Company will be completed in a short time. The Company has ordered several new cars for the extension.

SIOUX CITY, IOWA.—The construction of the first fifty miles of the Sioux City & Bijou Hills interurban will be started from here in the spring. C.

RAPID CITY, S. D.—An electric railroad to Belle Fourche, Spearfish, Deadwood, Lead, Sturgis and back to Rapid City, is projected by eastern capitalists. C.

ESTHERVILLE, IOWA.—An interurban line to Blue Earth, Minn., is being agitated by Chicago men, and it is expected that the survey for it will be startel shortly. C.

CHISHOLM, MINN.—The Mesaba Electric Company has secured a franchise to build an electric line from the Stevenson location to Gilbert, Minn., a distance of thirty-six miles. C.

INDIANAPOLIS, IND.—The Indianapolis, Columbus & Southern Traction Company is preparing to install a system of block signals on its line between Indianapolis and Louisville. S.

SPRINGFIELD, ILL.—Block signals costing $150,000 will be installed upon fifty miles of tracks of the Illinois Traction System. General Manager H. E. Chubbuck having signed a contract with the Union Switch and Signal Company. Z.

EAST ST. LOUIS, ILL.—The East St. Louis & Suburban Railway will try the "trolleyless" car on its lines, L. C. Haynes, vice-president and general manager, having recently returned from a visit to the works of Thomas A. Edison at Orange, N. J. Z.

HAVANA, CUBA.—According to a statement recently made by Robert Orr, manager of the United Railways of Havana, that company will spend about $3,000,000 for improvements during the coming year. Among other things a new passenger station will be built.

SAN ANTONIO, TEX.—The Board of County Commissioners of Bexar County has granted a franchise to J. A. Logwood for the construction of an electric railway from the terminus of the San Antonio Traction Company's tract at Harlandale south on the Corpus Christi road through a suburban district. D.

INDIANAPOLIS, IND.—The Beech Grove Interurban Traction Company has let a contract for placing the ties, laying the rails and ballasting the roadbed of its new line to Welch and McGregor. Work is to begin at once. The poles have all been placed and the overhead work is well along. The road will be in operation by Christmas. S.

PORTLAND, ORE.—John F. Stevens, chief executive of the Hill steam and electric railway interests here, has returned from the east and announces that the Hill interests will spend from $7,000,000 to $10,000,000 in the extensions of the United Railways and the Oregon Electric, within the next eighteen months. This means an addition of about 250 miles of electric lines tributary to this city. A.

INDIANAPOLIS, IND.—J. N. Crabb reports that the prospect of financing the Capital City Traction Company is good. This company is organized to build a traction line encircling Indianapolis at a radius of twenty-five miles connecting seven county seats with the Capital City. Mr. Crabb will urge the passage of a law compelling interurban and steam roads to exchange traffic cars. The object is to make his line a great belt road for the handling of freight. S.

DECATUR, ILL.—The Decatur & Southern Traction Company has filed notice with Secretary of State Rose of an increase in capital stock from $25,000 to $1,500,000. Peter Chase, president, announces that the division from Decatur to Witt, a distance of sixty-eight miles, will be built first, after which the line will be extended, going through Coffeen and Greenville to St. Louis. A belt line, one mile long, around the southwest part of Decatur, connecting with the Illinois Traction System belt line, is a part of the plans. Z.

LEESVILLE, LA.—The Lafourche Valley & Gulf Railroad Company, which was recently chartered, will construct a line between Donaldsonville to this city, a distance of nfnety miles. The capital of the company is $1,500,000, but work will be commenced when $5,000 has been paid in. The directors of the Company are F. M. Welch, president; J. Numa Colomb, first vice-president; Honore Dugas, second vice-president; Charles Maurin, secretary-treasurer; Clarence C. Barton, Sr., E. P. Munson, J. T. Badaux, John Marks and Sam A. Le Blanc.

HAMMOND, IND.—Three electric interurban companies are fighting to loop the cities of the Calumet region. The Gary and Interurban Railway Company, of Chicago, has introduced in the East Chicago council a petition for a franchise. The Hammond, Whiting and East Chicago line, of Chicago, now operating in the three cities, also wants to loop the district. A third company, financed by C. H. Geist, of Philadelphia, to fight the control of the Chicago, Lake Shore & South Bend Interurban Company, which markets its power and thereby competes with the Geist Electric Company, is also after a franchise. S.

SAN DIEGO, CAL.—The San Diego Electric Railway Company, of San Diego, Cal., has just placed an order with the Westinghouse Electric and Manufacturing Company, Pittsburg, for two 1,000-kilowatt, 600-volt, 514-revolution-per-minute generators to be driven by Westinghouse-Parsons low-pressure steam turbines running at 3,600 revolutions per minute. The generators and turbines will be connected through Melville-McAlpine reduction gears. In addition to this equipment the Westinghouse Company will shortly ship one 1,200-kilowatt, 600-volt, eighty-revolution-per-minute engine-type direct-current generator to the same company.

INDIANAPOLIS, IND.—The Indianapolis & Cincinnati Traction Company has effected a reorganization and been reincorporated by leaving the word "the" out of the name. The new corporation is capitalized at $3,000,000 and by a judical sale of the property of the old company the new company comes into possession of all the property and franchises of the old. Charles L. Henry is retained as president and general manager of the Company. Plans are now being made for extending the road from Connersville to Cincinnati by way of Harrison, Ohio. It is also proposed to build an extension of the Greensburg branch to Madison. S.

TELEPHONE AND TELEGRAPH.

(Special Correspondence.)

WORTHINGTON, MINN.—The telephone company is considering the installation of a new switch board. C.

WINONA, MINN.—The Tri-State Telephone Company has been granted permission to enter the city with its lines. C.

PORTLAND, TEX.—The Portland-Rosita Telephone Company has been incorporated, with a capital stock of $1,500. P.

WEYAUWEGA, WIS.—The Weyauwega Telephone Company has been incorporated with a capital stock of $3,500. P.

ARGYLE, MINN.—The Great Northern railway is installing a double circuit of copper wires for its telephone system. C.

DENHAM SPRINGS, LA.—The Maurepas Telephone Company is about to extend its lines from French Settlement to this point. P.

PUYALLUP, WASH.—It is stated that the entire local system of the Pacific Telephone & Telegraph Company will be built before the first of the year. C.

CUTHBERT, GA.—The Cotton Belt Telephone Company, of which C. J. O'Farrell is general manager, contemplates issuing $100,000 of bonds for the purpose of improving and extending its system.

ST. MARYS, O.—A new toll line has been established to Neptune by the local telephone company, and was opened for general use a short time ago. About thirteen miles of wire were used in the construction work. H.

HAMILTON, MONT.—The Rocky Mountain Bell Telephone Company will commence the immediate installment of additional equipment at an estimated cost of $12,000. About three-and-a-half miles of new cable will be laid. C.

NAPERVILLE, ILL.—The City Council has granted a twenty-five-year franchise to the Inter-State Telephone Company, which provides that after ten years from January 1, 1911, the Company shall pay the city five per cent of the gross rental earnings. Z.

HILLSBORO, N. D.—An increase of the capital stock of the Red River Valley Telephone Company of $100,000, making the total capital $200,000, is proposed and will be considered at the annual meeting of the stockholders to be held in Buxton December 13. The proposed increase is for the purpose of allowing the Company to extend its toll lines over a larger territory than is now occupied. This is one of the largest independent companies in the state.

ROCK ISLAND, ILL.—The Rock Island City Council has rejected a proposition to amend the franchise of the Union Electric Telephone and Telegraph Company making possible the sale of its rights to the Bell Company. S. R. Kenworthy representing the Tri-City Home Independent Telephone Company, an embryonic organization of Rock Island, Moline and Davenport proposed that a board of arbitration be appointed to fix the price of the holdings of the Union Electric Company and in the event of successful negotiations the Tri-City Company would pay each of the three cities a bonus of $5,000. Offer of the deposit of a certified check for $10,000 to prove sincerity of purpose was made. The arbiters, it is proposed, will be an engineer from the Union Company, one from the Tri-City Concern's interests and the third selected by the mayors of the three cities. Z.

MINNEAPOLIS, MINN.—The Northwestern Telephone Exchange Company expects its new three-story fireproof building at Thirty-eighth Street and Pillsbury Avenue will be completed about January 1, and the installation three months later. The switchboard will be on the second floor with places for forty-three operators and 5,400 lines with an ultimate capacity of 9,600 lines. Frames and racks, storage battery, motor-generator and wire chief's testing desk will be on the first floor, and the cable vault, gas engine and motor-heating and general storage rooms in the basement. The operators' rest room, forty-five feet square, the kitchen and other conveniences for the girls will be on the second floor. The Company also is enlarging its station at Second Avenue and Twenty-sixth Street from 1,000 lines to 7,800 lines and twelve operators' positions. Six positions and 1,000 lines are being added to the Nicollet exchange in the main building. Z.

ELECTRICAL SECURITIES.

Trading has been exceedingly light and prices, in general, have dropped, owing mostly to the inactivity of the market. It might be noted that the entire weeks business amounted to less than the average for one day at this time last year. Iron and steel are exceedingly quiet although a number of rail orders have been placed. Requests for tenders indicate that several more of considerable size are to be placed in the near future.

Current receipts of the Philadelphia Rapid Transit Company are averaging $59,000 per day, about $1,000 per day ahead of this time last year. A year's business at this rate would show gross earnings of more than $21,000,000, compared with $18,501,356 for the fiscal year ending June 30, 1910.

DIVIDENDS.

Mackey Companies; regular quarterly dividends of one and one-fourth per cent on the common and one per cent on the preferred stocks, payable January 3 to stock of record December 10.

Manhattan Railway Company; regular quarterly dividend of one and three-fourths per cent, guaranteed by the Interborough Rapid Transit System as rental, payable January 1 to stock of record December 15.

South Side Elevated; quarterly dividend of fifty cents a share, payable December 30.

CLOSING BID PRICES FOR ELECTRICAL SECURITIES ON THE LEADING EXCHANGES AS COMPARED WITH THE PREVIOUS WEEK.

NEW YORK.	Nov. 28.	Nov. 21.
Allis-Chalmers common	8¾	8
Allis-Chalmers preferred	33	32⅞
Amalgamated Copper	69⅝	70⅝
American Tel. & Cable	*84	*84
American Tel. & Tel.	142¾	143
Brooklyn Rapid Transit	77⅝	78⅛
General Electric	160	154⅛
Interborough-Metropolitan common	20½	21
Interborough-Metropolitan preferred	55½	56½
Kings County Electric	123	123
Mackay Companies (Postal Telegraph and Cables) common	90	90
Mackay Companies (Postal Telegraph and Cables) prefer'd.	74	73⅞
Manhattan Elevated	140	140½
Metropolitan Street Railway	*18	*18
New York & New Jersey Telephone	103	103
Pacific Tel. & Tel.	45	44¾
U. S. Steel common	79⅞	81½
U. S. Steel preferred	118⅛	117¾
Western Union	72¼	71
Westinghouse common	72	71
Westinghouse preferred	122½	120

*Last price quoted.

BOSTON.	Nov. 28.	Nov. 21.
American Tel. & Tel.	142	142⅛
Edison Elec. Illuminating	282	288
General Electric	160	154
Massachusetts Electric common	19¾	20⅝
Massachusetts Electric preferred	87	88¼
New England Telephone	137½	136
Western Tel. & Tel. common	17½	17
Western Tel. & Tel. preferred	91	90

PHILADELPHIA.	Nov. 28.	Nov. 21.
American Railways	43	43
Electric Company of America	11⅝	11¾
Electric Storage Battery common	49	47½
Electric Storage Battery preferred	49	47½
Philadelphia Electric	15¾	15⅝
Philadelphia Rapid Transit	18¾	17⅝
Philadelphia Traction	83	82½
Union Traction	44	39

CHICAGO.	Nov. 28.	Nov. 21.
Chicago Railways, Series 1	91	78½
hCicago Railways, Series 2	25⅛	22½
Chicago Subway	4¾	4¾
Chicago Telephone	122	123
Commonwealth Edison	115¾	115
Metropolitan Elevated common	19	19
Metropolitan Elevated preferred	62	61
National Carbon common	120	120
National Carbon preferred	119	118¾

PERSONAL MENTION.

C. E. PUTNAM has become instructor in electrical engineering at the Carnegie Technical School, Pittsburg, Pa.

JOHN A. FLEMING has been awarded the Hughes medal of the Royal Society of London for his researches in electricity.

CHARLES BRAZEL of Virginia, Ill., has accepted a position as manager for the Cass County Telephone Company at Ashland, Ill.

F. S. GASSWAY, formerly manager of the New York branch office of the Willard Storage Battery Company, has been transferred to the main office at Cleveland, O., where he will act as general manager of sales. In addition to the New York branch, the Willard Company has branches at Detroit, Chicago, and Mexico City.

W. H. FREEDMAN, formerly professor at the University of Vermont, has become head of the Department of Applied Electricity in Pratt Institute, Brooklyn, N. Y.

EDGAR F. SMITH, professor of chemistry in the University of Pennsylvania, lectured on "A Chapter in Electrochemistry" to the local chapter of the Society of Sigma Xi on November 21. Professor Smith has recently been made provost of the University and his election meets with approval in all quarters.

HENRY S. CARHART, emeritus professor of physics at the University of Michigan, has gone to Washington to undertake investigations connected with standard cells, at the Bureau of Standards.

HOWARD M. MORSE has recently severed his connection with the patent department of the General Electric Company in Schenectady to become associated with Dyer, Dyer & Taylor, patent lawyers.

H. R. KINGMAN, for eight years manager for the Citizens' Gas Electric & Heating Company at Mt. Vernon, Ill., has been made local manager for the Pacific Power & Light Company at North Yakima, Wash.

STEPHEN L. TABOR made an extended trip among the larger telephone exchanges of the country during the summer. Mr. Tabor is general supervisor of traffic of the South Western Telephone & Telegraph Company, with headquarters at Dallas, Tex.

HENRY G. REIST delivered the Founder's Day address at the fourteenth anniversary of the Clarkson Memorial School of Technology, Potsdam, N. Y., on the evening of December 2. Mr. Reist has been with the General Electric Company since its incorporation, and his design of alternating-current machinery includes some of the largest in the country.

JOSEPH W. RICHARDS, professor of metallurgy at Lehigh University, on December 1 gave a lecture before the Franklin Institute, Philadelphia, Pa., on "A Vacation Trip in Scandinavia With Some Observations on the Electrometallurgy of Iron and Steel." Dr. Richards is a leading authority in metallurgical, particularly in electro-metallurgical, subjects.

F. M. SINSABAUGH, for fourteen years manager of the properties of the Carrollton Heat, Light & Power Company of Carrollton, Ill., has resigned to accept a position as manager of the Citizens' Gas, Electric & Heating Company of Mt. Vernon. He also will have charge of the Indiana Water & Light Company of Worthington, Ind., and the St. Anne Light & Water Company of St. Anne, Ill. Mr. Sinsabaugh is a member of the executive committee of the Illinois State Electric Association.

FRANK H. MERRILL, who for ten years has been engaged in the electrical business in New York City, is now with the Chicago Fuse Wire and Manufacturing Company in the capacity of sales representative, with headquarters in Chicago. Mr. Merrill will pay special attention to the Chicago trade and will work in conjunction with Arthur S. Merrill. Messrs. F. H. and A. S. Merrill are brothers of Wm. W. Merrill, secretary of the Company.

MR. AND MRS. FRANK RIDLON observed the fiftieth anniversary of their marriage on the evening of Thursday, November 10, at their home, 140 Naple Road, Brookline, Mass., where they entertained relatives and friends, and received their congratulations. Mr. and Mrs. Ridlon were assisted in receiving by Mr. and Mrs. Frank Castner, their daughter and son-in-law. Music was furnished by an orchestra, and chrysanthemums and electrical effects contributed to a pretty scene. Mr. and Mrs. Ridlon were married fifty years ago in Boston, by the Rev. Joseph Copp. Both are natives of Boston, and Mrs. Ridlon before her marriage was Miss Marguerite Page. Mr. Ridlon is one of the early electric light men. He was for years active in the affairs of the National Electric Light Association, attending its first convention. He was also connected with the Brush-Swan Electric Light Company of New England, was president of the Boston Electric Light Company, and is now head of the Frank Ridlon Electrical Company.

FRANK RIDLON.

WILLIAM P. KENNEDY, sales manager of the commercial automobile department of the Studebaker organization, has been placed in charge of the field work of an extensive campaign for increasing the utilization of electrical commercial vehicles, in addition to his advisory function to the administration as consulting engineer. At a recent meeting at South Bend, Ind., the announcement was made to the branch managers that the executive committee had had under consideration for some weeks all the influences which tend towards impeding the progress of this department. Investigations of extraordinary character have been carried on and it has been decided that an effort of large dimensions will be carried out. The matter of locating the commercial-vehicle plant at Detroit, which has been under consideration, was decided in favor of retaining this division of production at South Bend, where it is likely additional buildings will be erected for the construction of the quantities of electric vehicles which is reasonably within expectation as result of the new campaign going into effect.

OBITUARY.

PIERRE PICARD, who is well known as the inventor of numerous improvements in connection with telegraphic transmission, died at Massy, France on November 7. Mr. Picard was the recipient of several honors, having been given the Cross of the Legion of Honor in 1903 and being later awarded the first Hughes prize by the Academie des Sciences. He was, at the time of his death, inspector of the Paris telegraphs.

OCTAVE CHANUTE, who has for many years been well known in engineering circles, died November 23 at his home in Chicago. Mr. Chanute was born in Paris in 1832, but came to America while quite young. He was interested in the problem of mechanical flight as early as 1874, and is said to have added more than any other one man to our knowledge of aviation. He experimented early with a single-plane gliding machine. Then he substituted two planes and added devices for steering and elevating and depressing. His experimental station was at Miller, Ind., and pictures of his early flight illustrate the first chapters of every history of aviation. Mr. Chanute was at one time president of the American Society of Civil Engineers, and also of the Western Society of Engineers. He was also a member of many other engineering organizations.

ADOLPH EMIL WEBER, well known to western telephone men, died of typhoid fever at his home in Guthrie, Okla. Mr. Weber was born in Cleveland, O., January 21, 1876. Few persons have been more intimately identified with telephone developments of the past fifteen years than has he. His early telephone training was acquired in his native city, after which he held responsible positions with the Southwestern Telephone Company of Texas and still later with the Engineering Inspection Company of the Western Electric Company in Chicago. Five years ago Mr. Weber entered the independent field and became state representative of the Kellogg Switchboard & Supply Company in Oklahoma and New Mexico, which position he held uninterruptedly until his death. His talents were freely exercised for the benefit of his customers and many modern independent plans throughout Oklahoma stand as monuments to his ability. Mr. Weber was a Scottish Rite Mason, also a member of the Benevolent and Protective Order of Elks. He likewise belonged to the United Commercial Travelers and was a member of the Church of Christ Scientists. He leaves a wife, four sisters and a brother, who, with a host of friends throughout the country, mourn his untimely death.

PROPOSALS.

LIGHTING FIXTURES.—Bids will be received until December 10, by C. W. Burnam, county auditor for electric light fixtures for the new court house and jail at Carrington, N. D. Buechner & Orth of St. Paul, Minn., are the architects. C.

NAVY DEPARTMENT SUPPLIES.—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will open bids on naval supplies on the dates given below. Bidders interested therein should make early application for copies of the schedule, giving the schedule numbers desired. Schedules can be obtained from the Navy Pay Office nearest each navy yard. Bids will be asked on the following supplies:

Date of Opening.	Material.	Quantity.	Place of Delivery.	Schedule No.
Dec. 6.—	Keyboards for night signal sets	6	Brooklyn, N. Y.	3114
	Switchboards	3	Brooklyn, N. Y.	3101
	Wire, copper, etc.	Miscellaneous	Brooklyn, N. Y.	3112
Dec. 27.—	Pump, power, motor-driven	1	Mare Island, Cal.	3099

FOREIGN TRADE OPPORTUNITIES.

(From *Daily Consular and Trade Reports*, issued by the Bureau of Manufactures, Washington, D. C. In replying to the Bureau for addresses refer to file number.)

No. 5772. TELEPHONE APPARATUS.—A report from an American consular officer in Latin America states that there is a movement on foot by a local company to install in place of the present telephone system a common battery system, employing the use of an electric switchboard and other appliances to make a complete and modern system. It is suggested that American firms wishing to bid on this apparatus should get in touch with the person in charge. As the purchasing will be for cash, he expects to receive the very lowest figures.

No. 5780. TRACKLESS TROLLEY CARS.—A prominent citizen in a city of the West Indies informs an American consular officer that he is anxious to introduce into one of the islands a system of running electric cars by means of double trollies, whereby the electric current is returned through a second wire, doing away with the necessity of rails. If such contrivances are produced in the United States, he would like to get in touch with the manufacturers at once.

NEW INCORPORATIONS.

ALBANY, N. Y.—The Electric Heat Storage Company has been incorporated with a capital of $1,500,000 by Thomas F. Murtha, Peter B. Hanson, L. R. Conklin and others.

CLEVELAND, O.—The Telephone Supply Company has been incorporated with a capital of $20,000. The incorporators are Wm. H. Marlett, F. H. Pelton, M. Jenkins, T. B. Bolton and M. B. Campbell.

LANSING, MICH.—Articles of incorporation have been filed with the Secretary of State by the Gogebic & Iron Countries Railway & Light Company, capitalized at $350,000; and the Consumers' Power Company, Manistee, $500,000.

INDIANAPOLIS, IND.—The Roberts Manufacturing Company has been incorporated to manufacture carburetors and other mechanical and electrical devices and equipment. W. H. Roberts, J. N. Kelley and Elmer Wetzel are directors. S.

NEW ALBANY, IND.—The Brown Automobile and Electric Company has incorporated with large capital to manufacture and deal in automobiles and electric appliances of all kinds. The incorporators are: W. H. and H. P. Brown and O. C. Thompson. S.

CHICAGO, ILL.—The Millar Electric Company has been incorporated with a capital of $10,000 for the purpose of manufacturing and dealing in electrical devices, machinery, etc. The incorporators are, James R. Offield, Charles J. Schmidt and Frank L. Belknap.

ST. LOUIS, MO.—The Missouri Battery & Lighting Company has been incorporated with a capital, fully paid, of $300,000. The incorporators are George F. McLain, Max Morris, H. W. Darby, L. E. Rickman and H. W. Toney. The company will manufacture and deal in the Darby primary batteries.

SPRINGFIELD, ILL.—Manufacturing and dealing in electrical appliances are, in part, the objects of the Gale Installation Company of Chicago, which was granted a certificate of incorporation. The concern is capitalized at $10,000 and the incorporators are Ning Eley, Hugo J. Thal and Frank W. Swett. Z.

ST. PAUL, MINN.—The Northwestern Electric Equipment Company, a New Jersey corporation, has filed articles of incorporation with the secretary of state. The company is capitalized at $600,000 and all stock is credited to Minnesota people. The Minnesota representative is F. B. Thompson of St. Paul.

INDUSTRIAL ITEMS.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, Pittsburg, Pa., has just issued section 3103 of its Perpetual Catalogue 3002-A on the subject of motor-driven elevators. The section contains a good many illustrations of typical installations.

THE L. S. STARRETT COMPANY, Athol, Mass., has issued Catalog No. 19 of its fine mechanical tools. Attention is called to the skill of the mechanics who manufacture these products and to the careful tests which all Starrett goods must pass before being placed on the market.

THE CHICAGO FUSE WIRE & MANUFACTURING COMPANY, Chicago, Ill., wishes to call attention to its new address, which is 1014-1022 W. Congress Street. Correspondence not addressed to this new location is liable to be delayed in delivery and cause inconvenience to customers.

THE FEDERAL SIGN SYSTEM ELECTRIC has issued Bulletin No. 131 on the Willis straight-line meter. Two double-page illustrations show the meters in full size. The Company has also sent out instructions for adjusting the meter. These are very complete, and are supplemented by several diagrams.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, O., recently issued a list of sales of motors. The Company mentions that among other orders it supplied two alternators to Cincinnati University, and a number of direct-current motors to the Marrowbone Coal and Coke Company, and the Cincinnati Bickford Tool Company.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., has issued Bulletin No. 1014 on the subject of central-battery non-multiple switchboards with magnetic signals. The circuits are indicated in the publication by diagrams, and various illustrations show the appearance of the boards in whole and in their various parts.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has issued a booklet on graphite products for the railroad. The object is to bring before the mechanical departments of the roads the various Dixon graphite products which are used in railway work. The book is attractively prepared and well illustrated.

THE PACIFIC ELECTRIC HEATING COMPANY, Ontario, Cal., has issued its November number of Hot Points, calling special attention to its goods in connection with the Christmas season. A folder describes a "Quartet of Xmas Suggestions." This includes the Hot Point electric iron, the El Tosto electric bread toaster, and the Hot Point utility outfit.

THE CHICAGO MICA COMPANY, Valparaiso, Ind., has presented to the trade its latest revised Catalog No. 19, on Micabond. This insulating material is already quite well known both for its high quality and its moderate cost. It is made in the form of tubing, tape, washers, as commutator insulation, and in other ways. The Company also deals in electrical mica, both cut and uncut, and complete price list of this material is given in the catalog.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, of St. Louis, announces the appointment of L. G. Bassett as its sales representative for the western part of New York State, with headquarters in Buffalo. Mr. Bassett has for some time been the manager of the apparatus department of McCarthy Bros. & Ford, who have represented the Wagner Company in this territory. McCarthy Bros. & Ford will continue their representation of the Wagner Company in the counties of Erie and Niagara, and Mr. Bassett will make his office in their building at 41-32 East Eagle Street.

THE AMERICAN CARBON & BATTERY COMPANY, East St. Louis, Ill., announces that it has recently acquired the business of the Doe Battery & Manufacturing Company, of Kent, O. The Company will continue the manufacture of the batteries in connection with the manufacture of carbon and graphite products. It is in a very favorable position to manufacture high-class dry cells by reason of its close identification with dry-battery work during the past ten years. The cells manufactured by this concern are the No. 6 American dry cells, the No. 6 American special-ignition dry cells, and the No. 8 American dry cells, all of which are described in a folder recently issued.

THE DE LAVAL STEAM TURBINE COMPANY, Trenton, N. J., announces that the Dravo-Doyle Company, by whom it has heretofore been represented in Pittsburg, Philadelphia and Cleveland, will open an office in Chicago at the Marquette Building in charge of H. S. Budd. The Dravo-Doyle Company has been very successful in the introduction of De Laval steam turbines for high and low steam pressure, and for direct connection to electrical generators, centrifugal pumps, blowers, etc., and has a wide experience in the general engineering and installation work connected with this kind of machinery, also with De Laval centrifugal pumps, including boiler feeding, hydraulic pressure service. These are described in a ninety-six page book on this subject recently published by the De Laval Steam Turbine Company.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, Pittsburg, Pa., has issued an illustrated booklet on the subject of unit switch control. The circular, numbered 1189, explains the plan of operation of this type of control, shows complete wiring and piping diagrams, and discusses the details of the apparatus. It is emphasized in the publication that mechanical power is rapidly superseding manual labor in every progressive industry. In electric traction, power-operated brakes have long since superseded the ordinary hand brake, except on the smaller cars. The general adoption of power-operated control apparatus in place of the manually operated controllers is the next logical step. One of the most important advantages of use of power-operated control is the ability to operate multiple-unit trains of two or more cars. This is of great assistance in handling heavy traffic under any circumstances, but particularly so on high-speed, single-track roads. Increased seating capacity on special occasions, obtained on such roads by operating additional cars as "second sections," or by reducing the usual headway, is always attended by increased danger of accident. Similar capacity obtained by the use of multiple-unit trains does not affect the usual train dispatching, and is therefore absolutely safe in this respect.

JOHN J. SCHAYER, Chicago, Ill., has established headquarters as the Western representative of several manufacturers in the new Peoples' Gas Building, Michigan Boulevard and Adams Street. Mr. Schayer was for seventeen years connected with the Edison interests in Chicago, starting in 1894 in the contract department of the old Chicago Edison Company, becoming later manager of several of the outlying companies, which were afterward consolidated in the Commonwealth Electric Company. Upon the consolidation of the Commonwealth Electric and the Chicago Edison into the Commonwealth Edison Company, Mr. Schayer became superintendent of the Northern district. Later on, when the district offices were consolidated with the downtown section, Mr. Schayer became secretary of the advisory committee, manager of the employment bureau, and manager of the beautiful electric shop which the Commonwealth Edison Company established some time ago on Michigan and Jackson Boulevards. A year ago, during the illness of Homer E. Niesz, Mr. Schayer acted as assistant manager and generally took charge of affairs of the Chicago Electrical Show. He has for a number of years been assistant manager of transportation of the National Electric Light Association, has been one of the managers of the Chicago Electric Club, and is one of the most popular and highly esteemed members of the electrical fraternity in and around Chicago. Mr. Schayer will represent the Niagara Lead & Battery Company, of Niagara Falls, N. Y., manufacturers of the Salom storage battery. This battery is possessed of several remarkable features, chief of which is the method of forming the active material initially, and pressing it into the supporting grids under great pressure, increasing the capacity of the battery and insuring long life through continued intimate contact of the active material with the supporting member. He will also represent the Sterling Bronze Company, New York, manufacturers of high-grade lighting fixtures and specialties. Also the Vulcalose Company, Chicago, Ill., manufacturers of a new high-grade insulating material. This is a substitute for hard rubber, which can be used as

a compound, moulded into any shape, worked, turned and drilled as readily as wood fibre. It is said that this material possesses some remarkable insulating qualities and it is expected that results of fracture, tensile and insulating tests will be issued shortly.

DATES AHEAD.

American Association for the Advancement of Science, and affiliated societies. Minneapolis, Minn., December 27-31.

Electrical Contractors' Association of New York State. Annual meeting, Albany, N. Y., January 16.

Chicago Electric Show. Coliseum, Chicago, Ill., January 7-21.

Minneapolis Electric Show. Minneapolis, Minn., January 26-February 4.

Iowa Electrical Association. Annual meeting, Davenport, Iowa, April 19, 20 and 21.

RECORD OF ELECTRICAL PATENTS.

Issued (United States Patent Office) November 22, 1910.

976,151. ELECTRICAL SYSTEM OF DISTRIBUTION. Rufus N. Chamberlain, Depew, and Marcellus R. Shedd, Lancaster, N. Y., assignor to Gould Storage Battery Company. Filed Dec. 17, 1906. Renewed April 9, 1909. A generator and battery system for trains.

976,158. SPARK-PLUG. George E. Edick, Manasquan, N. J. Filed Feb. 7, 1910. A central tube and a hooked portion constitute the electrodes.

976,159. ELECTRICALLY OPERATED SIGNALING HORN. Egmont Max Tormin, Newton, Mass., assignor to Holtzer-Cabot Electric Company, Brookline, Mass. Filed July 6, 1909. An electrically operated signaling horn comprises a horn, a casing secured to the inner end thereof, a diaphragm interposed between the horn and casing, an electromagnet having a hollow core, a plunger arranged within this core and having one end normally adjacent to, but not in contact with, the diaphragm, a resilient supporting member secured to the other end of the plunger, a circuit including the coil of the electromagnet, and means whereby the circuit may be automatically opened and closed.

976,164. BLUE-PRINTING MACHINERY. Morris Goldstein, Brooklyn, N. Y., assignor to Charles de Lukacsevics, New York, N. Y. Filed Nov. 23, 1908. Electric lamps are used for illumination.

976,172. TROLLEY-WHEEL. Edward K. Harris, Canandaigua, N. Y. Filed May 26, 1909. A trolley wheel has a peripheral tire formed of rubber and is provided with a peripheral groove adapted to receive a trolley wire, the wire having a metallic facing within the groove and electrically connected to the rim of the wheel.

976,184. SERVICE-METER SYSTEM. Guy A. Joy, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. Filed April 6, 1908. A telephone meter.

976,196. SUBSTATION-CIRCUIT. John J. Lyng, East Orange, N. J., assignor to Western Electric Company, Chicago, Ill. Filed March 11, 1909. A substation telephone apparatus.

976,207. FILAMENT OR RESISTOR FOR HEATING UNITS OR LAMPS. Herschel C. Parker and Walter G. Clark, New York, N. Y., assignors to Parker-Clark Electric Company, New York, N. Y. Filed May 20, 1909. A resistor in filament form consists of a core or base with a non-metallic coating thereon, the whole when cold being a conductor of electricity throughout its mass and which will glow continuously in the open air at a temperature of incandescence.

976,214. SIGNAL ATTACHMENT FOR CLOCKS. Owen P. Ragan, Ridgeway, Mo. Filed March 16, 1910. A clock hand, forming part of an electric circuit, has pivoted to it a brush which engages with contacts round the face. The brush is put into operative position by a supporting cam roller which is partially rotated at predetermined time.

976,216. ELECTRICAL RELAY. Foster Ritchie, Acton, England. Filed December 16, 1905. The method of setting up and reinforcing the line impulse in relays which are operated by transient currents or impulses consists in setting up an impulse in the relay to cause an initial movement in the armature of the relay, and immediately thereafter setting up an induced impulse in the circuit including the relay and in the same direction as the first impulse.

976,230. TELEPHONE-RECEIVER. Harve R. Stuart, Newark, N. J. Filed June 29, 1909. A telephone receiver comprises a generally cylindrical casing having an eccentric diaphragm, a pair of solenoids within the casing, an armature having a grooved portion and having polar extensions projecting into the solenoids, an iron post received in the grooved portion of the armature, a permanent magnet joined to the post and having polar extensions also projecting into the solenoids, and a connection from the armature to the diaphragm.

976,241. TELEPHONE TRUNKING SYSTEM. Charles S. Winston, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. Filed November 17, 1906. A periodically actuated relay, for connecting the source of ringing current with the talking strands of the trunk circuit, may be automatically rendered inoperative by a device controlled in some way by the condition of the called subscriber's telephone.

976,248. INCANDESCENT LAMP. George F. Atwood, Newark, N. J., assignor to Westinghouse Lamp Company. Filed January 3, 1910. An incandescent lamp comprises filament supports, and a filament having its end portions coiled around the supports and its extremities united thereto.

976,277. ELECTROLYTE FOR ALKALINE BATTERIES. William Morrison, Des Moines, Iowa. Filed May 6, 1909. An alkaline hydrate electrolyte contains a compound capable of rendering the zinc negative pole electrode substantially or largely insoluble in the electrolyte.

976,278. PROCESS OF MANUFACTURING MATERIAL FOR ALKALINE BATTERIES. William Morrison, Des Moines, Iowa. Filed September 26, 1910. The method of producing a compound for use in reversible galvanic batteries consists in first taking a mixture of zinc oxide and water and in agitating the same, then adding a suitable amount of chromium sulphate to this mixture while it is being agitated, whereby a compound zinc oxide and chromium sulphate is obtained, then acting upon this with a strong alkaline solution to remove the sulphate, thus leaving a compound of zinc chromium oxide and in then washing this compound to remove traces of the sulphate.

976,279. PROCESS FOR MAKING MATERIAL FOR ALKALINE BATTERIES. William Morrison, Des Moines, Iowa. Filed October 10, 1910. The process of producing a compound for use in reversible alkaline batteries comprises electrolytically reducing a compound containing zinc chromate in the presence of an alkaline electrolyte.

976,287. AUTOMATICALLY-FLASHING ELECTRIC LAMP. William J. Phelps, Detroit, Mich.; J. Wiley Phelps, administrator of said William J. Phelps, deceased, assignor to The Electro-Ad Company, Detroit, Mich. Filed July 16, 1903. An electric incandescent lamp has two filaments of different candlepower connected in series and a thermostatic switch mounted within the neck of the lamp, exposed to and operated by the heat of the filaments and arranged to automatically open and close a short circuit around the low-power filament.

976,298. SELECTIVE PARTY-LINE TELEPHONE SYSTEM. Homer J. Roberts, Evanston, Ill., assignor to Homer Roberts Telephone Co. Filed September 18, 1902. One line in sections extending from station to station and the other continuous of wave are means for establishing a bridging connection between section line and continuous line at each substation, and means operable from the central station for establishing a grounded return circuit at each substation.

976,345. SPARK-TIMING DEVICE FOR EXPLOSIVE-ENGINES. Eugene A. Cooper, Britton, S. D. Filed March 25, 1907. A spark-timing device comprises a shaft, a ring secured thereon, and having a socket in its periphery, a tongue pivoted at one end in this socket and decreasing in thickness from its longitudinal center toward each edge and adapted to rock on its pivot pin and electrodes inclosing the shaft and between which the tongue is adapted to sweep by the revolution of the shaft.

976,380. SELECTIVE SIGNALING SYSTEM. Oscar M. Leich, Genoa, Ill., assignor to Cracraft-Leich Electric Company, Genoa, Ill. Filed December 10, 1908. A step-by-step signal-receiving device comprises a local signal and an electric circuit for the signal, a movable step-by-step mechanism and a slower-moving clock mechanism adapted conjointly when started after the clock mechanism overtakes the step-by-step mechanism to change the circuit conditions through the local signal, thereby to operate same.

976,404. ELECTRICAL HEATER. Milton H. Shoenberg and George T. Marsh, San Francisco, Cal., assignors to Appliance and Electric Device Company. Filed January 28, 1909. An electrical heater comprises single flat conducting cores, conducting resistance coils wound about the cores, insulating mediums interposed between coils and cores, other insulations inclosing the coils, exterior closed seamless tubing flattened and compressed upon the outside of the exterior insulations, a container adapted to receive individual heating elements, and connections in series between these members.

976,405. ELECTRIC HEATER. Milton H. Shoenberg, San Fran-

cisco, Cal., assignor to The Presto Electrical Manufacturing Company. Filed June 1, 1910. An electric heater comprises a casing open at both ends, a tubular handle secured thereto and extending at right angles therefrom, a tubular spool within the casing having both ends open and registering with the ends of the casing, the cavity between the spool and casing within the cavity, an insulating medium separating the wire being closed at both ends, a high-resistance wire upon the spool from the spool, and conducting wires passing through the handle and connected to the resistance wire.

976,420. DYNAMO-ELECTRIC MACHINE. Robert B. Williamson, Milwaukee, Wis., assignor to Allis-Chalmers Company, a Corporation of New Jersey. Filed April 17, 1909. The stator comprises a housing having transverse ribs and a core supported thereby, the ribs having ventilating openings and dampers for regulating the effective sizes of the ventilating openings. The rotor is provided with means for forcing air through the ventilating openings.

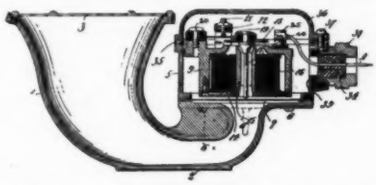
976,445. TROLLEY-HEAD. Edward E. Duff, Seattle, Wash., assignor of one-half to David V. Ackerman, Mount Vernon, Wash. Filed Aug. 11, 1909. Has a depending bracket harp.

976,454. ELECTROLYTE FOR DEPOSITING COPPER. William G. Grey and William Griffith, Pittsburg, Pa. Filed Feb. 23, 1910. An electrolyte for depositing a metallic coating, comprises a solution of one gallon of water, two and one-half ounces copper red compound, three ounces cyanide of potassium, and one ounce bisulphite of soda.

976,457. TELEPHONE MOUTHPIECE. Josephine A. Hall, Oakland, Cal. Filed Feb. 10, 1910. A telephone mouthpiece attachment comprising a shell having a flared intermediate portion with a straight outer end and a contracted inner end, fingers formed on the inner end of the shell, the outer end being provided with a plurality of perforations, a circular pad surrounding the outer end of the shell and a clamping ring securing the pad about the end.

976,487. COMBINED CARBURETER-PROTECTOR AND ELECTRIC CUT-OUT FOR AUTOMOBILES. William O. Nelson, Baltimore, Md. Filed May 25, 1908. Opening of a cover (for a hollow member in the gas line between the motor and carburetor) breaks the spark-plug circuit.

976,500. WIRELESS TELEGRAPHY. Frederick G. Sargent, Graniteville, Mass. Filed August 26, 1905. A coherer comprises a



976,159.—ELECTRIC SIGNALING HORN.

tube composed of extensible material, rods entering opposite ends of the tube and having said ends connected therewith, and the cohering material between the proximate ends of the rods.

976,501. TROLLEY-POLE. Philip Schnell, Philadelphia, Pa. Filed February 11, 1910. normally vertical pole with yielding trolley is guyed by extensible side wires.

976,519. ELECTRIC-LAMP SOCKET. James S. Stewart, New York, N. Y., assignor to Annie Stewart, New York, N. Y. Filed March 19, 1910. A bayonet socket.

976,524. AUTOMATIC TELEPHONE SYSTEM. Harry G. Webster, Chicago, Ill., assignor, by mesne assignments, to Kellogg Switchboard and Supply Company. Filed March 6, 1909. A selector for automatic exchanges includes terminal contacts arranged in groups, wiper contacts, one for each of the groups, electromagnets for the selector, one for each group, and circuit means for operating the magnet of a group to render the respective wiper contact "live" or operative.

976,526. MANUFACTURE OF ELECTRIC FILAMENTS. Carl Auer von Welsbach, Vienna, Austria-Hungary, assignor to Welsbach Light Company, Gloucester City, N. J. Filed August 9, 1898. A filament for an electric incandescent lamp is composed of a series of osmium particles electrically welded into a dense coherent and elastic self-sustaining strip or thread which will incandesce at a temperature above that at which platinum melts.

976,527. MANUFACTURE OF ELECTRIC FILAMENTS. Carl Auer von Welsbach, Vienna, Austria-Hungary, assignor to Welsbach Light Company, Gloucester City, N. J. Filed August 9, 1898. The method of manufacturing incandescent electric filaments, consists in associating organic thread with osmium; then, subjecting the thread to dry distillation; and then, by the action of the electric current, in a suitable atmosphere eliminating the carbon and uniting the metallic particles into a coherent filament of metallic osmium.

976,528. MANUFACTURE OF ELECTRIC FILAMENTS. Carl Auer von Welsbach, Vienna, Austria-Hungary, assignor to Welsbach Light Company, Gloucester City, N. J. Filed August 9, 1898. An incandescent electric lamp has its filament connected to its leading-in wires by a connecting body of osmium.

976,532. ELECTRIC CONNECTING DEVICE. Herbert C. Wirt, Schenectady, N. Y., assignor to General Electric Company. Filed April 28, 1906. A terminal connector is provided at one end with wire-engaging means and extending at the other end into the space between the arms of a contact clip.

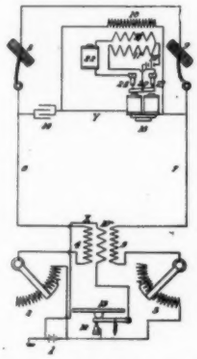
976,537. TELEGRAPH-TRANSMITTER. John C. Barclay, Montclair, N. J. Filed March 22, 1909. A telegraph transmitter comprises a rotary member, means for arresting same in different angular positions, and contact means operated thereby comprising a vibrator including a resilient member and contacts between which the vibrator moves.

976,549. SWITCH. Herbert W. Cheney, Norwood, O., assignor to Allis-Chalmers Company and The Bullock Electric Manufacturing Company. Filed October 22, 1906. A multipole switch or circuit breaker.

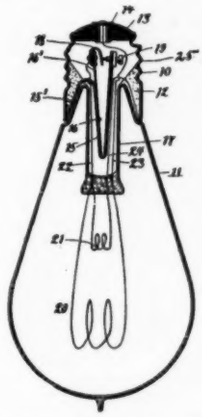
976,562. ELECTRIC ALARM AND CALL-BELL SYSTEM. James Haslip Field, Victoria, British Columbia, Canada, assignor to The Canadian Taylor Automatic Fire Alarm and Call Bell Company, Limited. Filed January 25, 1909. Has special switch connections.

976,578. POLICE SIGNAL DEVICE. Earl J. Kingsley, John Greene, and William Guy Sadleir, Salt Lake City, Utah. Filed Dec. 13, 1907. A cam opens the circuit suddenly.

976,586. RELAY-MAGNET. James F. McElroy and John E. Macomber, Albany, N. Y., assignors to Consolidated Car Heating Company. Filed May 13, 1910. The magnet has a sheet-metal



976,216.—ELECTRICAL RELAY.



976,287.—ELECTRIC LAMP.

armature, a sheet-metal supporting piece for the armature and having a loose connection therewith, a sheet-metal loop carried by the aramture, and a contact piece loosely secured to the loop.

976,615. ELECTRIC RADIATOR. John A. Tuper, Montpelier, Idaho. Filed August 31, 1909. Resistance coils or wires are located in the annular spaces of a radiator of the usual hot-water or steam type.

976,616. MANUFACTURE OF ELECTRIC FILAMENTS. Carl Auer von Welsbach, Vienna, Austria-Hungary, assignor to Welsbach Light Company, Gloucester City, N. J. Filed August 9, 1898. A flexible, elastic, incandescent filament for an electric lamp is formed of metallic osmium arranged in a plurality of superimposed minute layers or lamins all rendered compact and coherent.

976,617. RAIL-BOND. Eugene M. Weaver, Jamaica, N. Y., assignor to General Electric Company. Filed July 20, 1910. In a rail bond a main body of stranded wire has an outer armor of larger wire than the inner wire.

976,634. LAMP-BRACKET. Thomas H. Cassidy, Cranbrook, British Columbia, Canada. Filed January 28, 1910. A wall bracket fixture includes a widing spool, etc., for a lamp cord.

976,645. ELECTRICAL FIRE-ALARM SYSTEM. James Haslip Field, Victoria, British Columbia, Canada, assignor to The Canadian Taylor Automatic Fire Alarm and Call Bell Company, Limited, Victoria, Canada. Filed February 3, 1909. An alarm bell and battery are connected in series with the circuit in connection in a plurality of general thermostats, and a master thermostat co-operates with the aforesaid parts to render the general thermostats inoperative under predetermined conditions.

976,654. ELECTRICAL SWITCH. John D. Hillard, Albany, N. Y. Filed July 26, 1907. Includes arc-destroying means.

976,670. END RING FOR INDUCTION-MOTORS. Howard Maxwell, Schenectady, N. Y., assignor to General Electric Company. Filed February 28, 1910. Connections between the rotor con-

ductors and an end ring consist of conductors doubled, back on themselves so as to have an appreciable length with minimum self-induction.

976,728. TROLLEY FOR ELECTRIC CARS. Armando Del Valle, New York, N. Y., assignor of one-half to Charles J. Bender, New York, N. Y. Filed July 5, 1910. In combination with a trolley having a wheel pinned to revolve within a forked end of the trolley pole is a contact retainer comprising two sides pivoted near their upper ends to the fork of the trolley to swing in the plane of the trolley wheel, a weight secured between the sides near the lower ends to space the sides and insure stability, and retainers positioned above the trolley wheel having stems mounted to revolve in the side members and to spread outwardly.

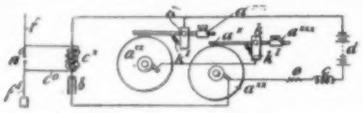
976,743. LIGHTING AND BATTERY CIRCUITS. James F. McElroy, Albany, N. Y., assignor to Consolidated Car Heating Company. Filed April 29, 1910. A relay opens the lamp circuit.

976,747. BATTERY TEMPERATURE-CONTROLLER. Frederick W. Schmidt, Philadelphia, Pa. Filed January 13, 1910. A thermostat is immersed in the battery solution.

976,748. CONTROL FOR CHARGING STORAGE BATTERIES. Frederick W. Schmidt, Philadelphia, Pa. Filed May 4, 1910. A thermostat has an electrically conducting acid-resisting metallic casing, and an apertured insulating jacket inclosing such casing.

976,749. THERMOSTAT. Frederick W. Schmidt, Philadelphia, Pa. Original application filed January 13, 1910. Divided and this application filed August 8, 1910. A thermostat is provided with an acid-resisting and electrically-conductive casing and has two contacts, one of which is electrically connected to the casing.

976,750. CONTROL FOR CHARGING STORAGE BATTERIES. Frederick W. Schmidt, Philadelphia, Pa. Original application filed May 4, 1910. Divided and this application filed August 8, 1910. The device includes a charging circuit, a storage battery in such circuit, means in the circuit for cutting out the battery, and a thermostat having an electrically conducting and acid-resisting casing and wholly within the storage battery and connected to control the cutting-out means.



976,778.—APPARATUS FOR PRODUCING AND UTILIZING HIGH-PERIODICITY CURRENTS.

976,778. APPARATUS FOR PRODUCING AND UTILIZING ELECTRIC CURRENTS OF HIGH PERIODICITY. Sidney George Brown, London, England. Filed December 17, 1906. A spark gap is formed between a balanced metal pole and a revolving disk on which the metal pole lightly rests. A source of continuous current is in series with the gap. An oscillatory circuit shunts the gap; and a microphone varies the periodicity of the oscillatory circuit by varying the resistance.

976,791. STORAGE-BATTERY ELECTRODE. Thomas A. Edison, Llewellyn Park, Orange, and Jonas W. Alysworth, East Orange, N. J., assignors to Edison Storage Battery Company, West Orange, N. J. Filed April 28, 1905. An electrode unit comprises a substantially non-deformable, perforated, inclosing pocket made from metal of comparatively high tensile strength and active material compressed therein, and maintained under elastic pressure.

976,792. STORAGE BATTERY. Thomas A. Edison, Llewellyn Park, West Orange, N. J., assignor to Edison Storage Battery Company, West Orange, N. J. Filed May 24, 1910. A storage battery comprises a supporting plat, a plurality of perforated tubes mounted side by side upon the plate, the tubes being formed of ribbons of resilient metal, spirally wound, the spiral winding of the tubes as mounted being alternately right and left handed, the tubes containing highly compressed active material under a constant tendency to expand, and means carried by the plate for supporting the tubes.

976,797. SPARKING PLUG FOR INTERNAL-COMBUSTION ENGINES. Robert Frederick Hall, Moseley, Birmingham, England. Filed October 30, 1908. The plug has an insulator body part provided with a hole which tapers uniformly from end to end of the insulator body part, and a central conductor rod provided with an enlarged taper-sided collar adapted to make a locking wedge connection directly with the wall of the internal hole in the body, the taper-sided part of the rod being provided with annular gas-check rings or grooves.

976,822. SUBMARINE SIGNALING. Josiah B. Millet, Boston, Mass., assignor to Millet Signal Company, Boston, Mass. Filed June 23, 1909. The method of determining on board a vessel or the like the direction of a source of submarine sound consists in acoustically applying a microphonic sound detector to one part of the ship's hull, transferring and acoustically applying the same detector to another part of the ship's hull, and comparing the relative intensities of the sounds produced.

976,824. GRID FOR REVERSIBLE GALVANIC BATTERIES. William Morrison, Des Moines, Iowa. Filed Sept. 26, 1910. A pressed or stamped grid for use in reversible batteries, in which an alkaline electrolyte is used comprises a bottom section having a plurality of openings stamped therein and projections extending upwardly therefrom, an upper section having a plurality of openings therein and projections extending downwardly therefrom, the projections of one plate extending substantially through the openings in the other plate.

REISSUE.

13,174. SECONDARY BATTERY. William Morrison, Des Moines, Iowa. Filed May 28, 1909. Original No. 916,575, dated March 30, 1909. An electric reversible galvanic battery in which there is a suitable alkaline electrolyte, has a positive pole electrode and a negative pole electrode containing zinc, the zinc element being in excess of that which the electrolyte can take up in solution, the major part of the zinc being oxidized in the working of the battery, without being taken up in the solution, to produce electric current.

PATENTS THAT HAVE EXPIRED.

Following is a record of the electrical patents (issued by the United States Patent Office) that expired November 28, 1910:

509,363. ELECTRIC-CURRENT REGULATOR. John H. Clark, Boston, Mass.

509,367. SWITCHBOARD-CIRCUIT AND SIGNALING APPARATUS. Francis W. Dunbar and Edmund S. C. May, Newark, N. J.

509,373. ELECTRICALLY-OPERATED JUMPER DRILL. Carl Hoffmann, Berlin, Germany.

509,381. BATTERY-BOX AND CASE. Linwood F. Jordon, Somerville, Mass.

509,397. ELECTRIC ELEVATOR. Charles R. Pratt, New York, N. Y.

509,403. ELECTRIC CLOSED-CONDUIT SYSTEM FOR RAILWAYS. George W. von Siemens, Berlin, Germany.

509,421. CONDUIT ELECTRIC RAILWAY. Adolph Worner, Buda-Pesth, Austria-Hungary.

509,430. PRINTING-TELEGRAPH. Robert A. Fowden, Philadelphia, Pa.

509,443. ELECTRIC-LIGHTING SYSTEM. James B. McGiffert, Elizabeth, N. J.

509,445. COMBINED ELECTRIC MOTOR AND INDUCTION-COIL. John S. Nowotny, Cincinnati, Ohio.

509,447. TRAIN SIGNALING APPARATUS. Joseph S. H. Pellat, Paris, France.

509,475. COMPOUNDING DYNAMO-ELECTRIC MACHINES. Walter H. Knight, Lynn, Mass.

509,477. TRUNK-LINE SIGNAL. Edmund S. C. May, Chicago, Ill.

509,484. SIGNAL APPARATUS FOR TELEPHONE SYSTEMS. Joseph J. O'Connell, Chicago, Ill.

509,499. REGULATOR FOR DYNAMO-ELECTRIC MACHINES. Elihu Thomson, Swampscott, Mass.

509,500. ELECTRIC DOUBLE-POLE FIXTURE CUT-OUT. Henry E. Werline, Lancaster, Pa.

509,501. ELECTRIC PENDANT CUT-OUT. Henry E. Werline, Lancaster, Pa.

509,505. SWITCHING APPARATUS FOR ELECTRIC MOTORS. Parvin Wright and Joseph W. Kinsey, Denver, Colo.

509,517. SYSTEM OF ELECTRICAL DISTRIBUTION. Thomas A. Edison, Menlo Park, N. J.

509,524. POLICE AND FIRE ALARM SYSTEM. James B. Gill, San Francisco, Cal.

509,530. TELEPHONIC APPARATUS. William S. Harrison, Hong-Kong, China.

509,539. ELECTRIC SWITCH. Charles J. Klien, New York, N. Y.

509,545. SIGNAL APPARATUS. George McIntosh, Stonington, Conn.

509,556. ELECTRIC PLOW. Charles H. Roberts, Eau Claire, Wis.

509,578. POTENTIAL-INDICATOR. George A. Linter, Minneapolis, Minn.

509,603. COUPLING FOR ELECTRIC CONDUITS. Augustus Noll, New York, N. Y.

509,651. CLOSED-CONDUIT SYSTEM FOR ELECTRIC RAILWAYS. Emile Chabeault, Marseilles, France.

509,662. DYNAMO-ELECTRIC MACHINE. Carl Hoffmann, Berlin, Germany.

509,680. ELECTRO-MAGNETIC ALARM. Parnell Rabbidge, Sydney, New South Wales.

509,705. ELECTRO-MAGNETIC RECIPROCATING MOTOR. Richard Threlfall, Sydney, New South Wales.

509,750. ELECTRIC-CURRENT METER. William T. M. Mortram, Dallas, Tex.

509,776. ELECTRICAL CONTROLLER. Elmer A. Sperry, Cleveland, Ohio.

509,783. LIGHTNING-ARRESTER. Alexander Wurts, Pittsburg, Pa.

509,784. UNIVERSAL NON-ARCING LIGHTNING-ARRESTER. Alexander Wurts, Pittsburg, Pa.

509,821. ELECTRIC ELEVATOR. Francis B. Perkins, Boston, Mass.

509,842. ELECTRIC-ARC LAMP. Ernest P. Clark, New York, N. Y.